THE JOURNAL OF
Engineering Education

March, 1952 Vol. 42, No. 7

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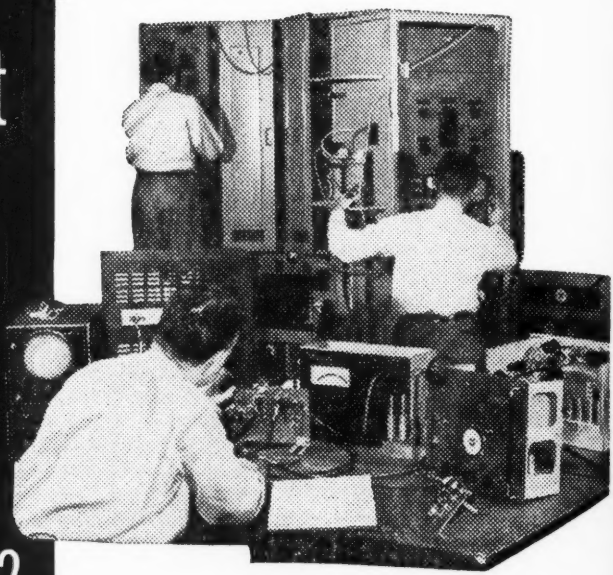

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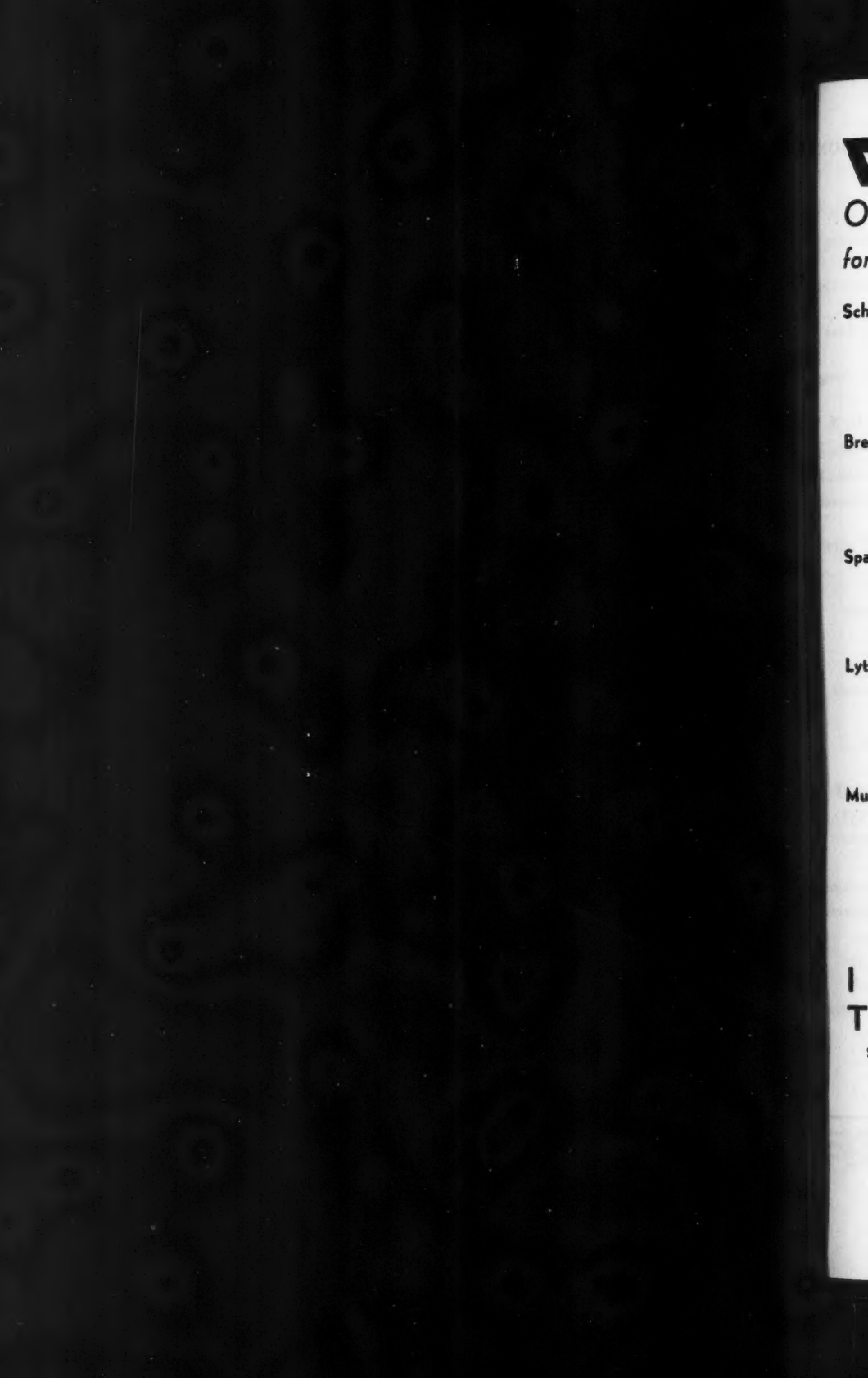

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Published monthly (except during July and August) at Prince and Lemon Sts., Lancaster, Pa., by the American Society for Engineering Education under the Supervision of the Publication Committee: A. B. Bronwell, Chairman, Northwestern University, S. C. Hollister, F. M. Dawson, C. E. Watson, Editor. Entered as second class matter, October 17, 1912, at the Post Office at Lancaster, Pa., under the Act of August 12, 1912. Subscription Price, $5.00 per year; Single Copies, $1.00.

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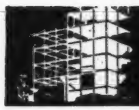

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The Gift of Engineering*

By L. E. GRINTER
Vice President of the ASEE

In the Beginning only Divine Force could have guided creation of the Universe and the evolution of life on Earth. All creatures endured the forces of nature until the mind of man matured. Then man's desires sought satisfaction by invention of tools to strengthen his hand. But tool making brought civilization with collective cares outreaching the ability of arms even when aided by the lever and wheel. Slowly our forebears began to discover natural laws that explained the drawing of power from falling water, wind and steam. It was only in our fathers' time that electricity on wires, and then on wireless waves encircled the earth, yet *we* have cradled atomic change and released the latent energy that lights the stars, thereby threatening the existence of our enemies and of our own children. It is the engineer's destiny to control and direct power in order to "provide for the common defense, promote the general welfare," and so to help "secure the blessings of liberty to ourselves and our posterity."

As an engineer you are given a favored part in this great design; without you the plan would be less perfect. When you build a bridge, design a dam, perfect a process or link power lines together you play a role in the achievement of human destiny. You therefore owe everything that you have to give in honest and sincere effort toward engineering progress. Dishonesty is inconceivable in even the smallest detail of a professional mission. Carelessness and sloth are but little less reproachable. Integrity and energy deepen the luster placed upon the profession of engineer by the master builders of the past. Disclosure of advances must be given freely to aid in educating the engineers of the future. Thus with each generation rising above the teaching of its forerunner, progress by employment of science is the gift of engineering to mankind. With this gift must go the engineer's unending effort that ethics may mark its use and morality remain its master.

* From an address to Engineering Students.

Dartmouth College

Annual Meeting, ASEE, June 23-27, 1952

When the American Society for Engineering Education visits the Dartmouth campus for its national meeting next June it will be gathering in former Indian territory that retains its tribal character only in the traditions of the college and in the nicknames of the Dartmouth athletic teams.

It was his zeal in carrying his educational and missionary work to the northern tribes that prompted the Rev. Eleazar Wheelock to transport his Indian charity school from Connecticut to Hanover, in the New Hampshire wilderness, and there to plant the seed for one of the nation's oldest and most distinguished institutions of higher learning. The royal charter of Dartmouth College was granted in 1769 by King George III of England, "for the education & instruction of Youth of the Indian Tribes in this Land in reading, writing & all parts of Learning which shall appear necessary and expedient for civilizing and christianizing Children of Pagans as well as in all liberal Arts and Sciences, and also of English Youth and any others." The college, whose founding funds had been raised in England by the Indian Samson Occom, was named for the Second Earl of Dartmouth, its sponsor and benefactor in the mother country.

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"Dartmouth College Case"

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The other great influence in Dartmouth's history was the leadership of President William Jewett Tucker from 1893 to 1909. It was during this administration that Dartmouth began its real development from a provincial New England college to the national institution it is today. The broad outlines of modern Dartmouth were clearly envisioned by Dr. Tucker, who, although he had been a professor of theology, proved also to be a bold and skillful administrator. The groundwork he laid enabled Dartmouth to enjoy, immediately after World War I, perhaps

the greatest growth and development of any historic college in the country. The long administration of Dr. Ernest Martin Hopkins, from 1916 to 1945, was the perfect complement to the Tucker period in carrying even beyond fruition the plans made at the turn of the century.

Dartmouth's president today is Dr. John Sloan Dickey. He left a distinguished career in law and government service to become head of the college six years ago. He has been intent upon sharpening the college's educational purpose, with emphasis on public-mindedness as a core attribute of the liberally educated man. This sharper focus on useful and intelligent citizenship has been most strikingly embodied in the Great Issues Course, inaugurated in 1947 as a requirement for all seniors. A new Department of Russian Civilization, introduced this fall, has been another important step in relating the liberal arts curriculum to the issues and needs of the modern world.

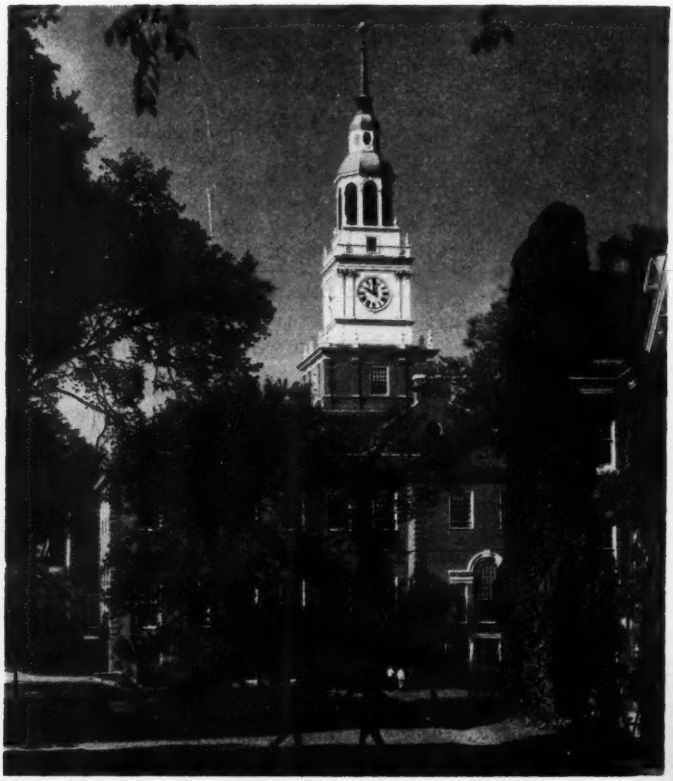
Three Associated Schools

Dartmouth's all-male enrollment this year includes 2,600 undergraduates and approximately 175 graduate students in the three associated schools. Total enrollment in the latter schools is much larger, however, because of the Dartmouth plan of having men begin their engineering, medical and business studies in the senior year. Although it is a New England College, Dartmouth draws two-thirds of its student body from other sections of the country and normally has men from every state. In 1950–51, twenty-six foreign lands were also represented in the student body, which is divided about evenly between men from public and private preparatory schools. The freshman class, varying from 700 to 750 each year, is chosen from an application list of three to four times that number. The admissions plan strives for economic diversity as well as a wide geographic spread, and about one-fourth of Dartmouth students are granted scholarships or other forms of financial aid. The amount of such aid this year will total $422,000.

The Dartmouth faculty of some 300 members is large in comparison with the size of the student body and gives a ratio of teachers to students of about one to nine. Classes average about twenty-two men in size, but one-third of all courses have less than ten men enrolled. Small classes, with close, personal faculty supervision, are especially the rule in the associated schools of engineering, medicine and business administration. Dartmouth faculty members have always enjoyed a rare degree of academic freedom and this is one of the traditions most zealously preserved by the college.

The Dartmouth curriculum is divided into three division: the humanities, the sciences, and the social sciences. Thirty-two different departments are grouped under these three main divisions. In addition to Russian Civilization, two other new departments were added this fall for the work of the Army and the Air Force ROTC Units which have joined the Navy ROTC Unit on the campus. The Dartmouth educational plan prescribes a balanced distribution of courses in the freshman and sophmore years, and allows freedom of election in the last two years, with each student required to major in one field of study and to demonstrate his mastery of that field by passing a comprehensive examination at the end of the senior year. A number of inter-departmental majors are offered, and this year the new Department of Russian Civilization offers the first inter-divisional major in the college's history.

Students of exceptional ability are permitted to set their own educational pace by doing honors work under faculty tutors, and an even greater degree of freedom is given each year to a selected group of Senior Fellows who pursue their studies entirely outside of the regular curricular channels. The only degree awarded by the undergraduate college is that of Bachelor of Arts. The Master's degree is awarded each year to a small number of Teaching Fellows, usually in



Baker Memorial Library, Dartmouth College

the sciences, and in a rare instance a graduate student might receive his Ph.D. at Dartmouth.

The Great Issues Course, now in its fifth year, has attracted wide attention throughout the college world and has provided the pattern for similar courses in at least twenty other institutions. Two features of special interest are the Public Affairs Laboratory in Baker Library and the plan of visiting lecturers whereby authorities of national and international repute are brought to the campus to lecture on each issue and to remain over for a give-and-take discussion with the senior class the next day.

Baker Library, which has a special basement wing devoted to the Public Affairs Laboratory, houses 700,000 volumes and in its scholarly resources outranks the libraries of most of the large universities of the country. When it was completed in 1928 it provided the exceptional center needed for the modern Dartmouth curriculum with its emphasis on individual work and extensive reading in the student's chosen field of study. Baker Library is operated on an informal basis with an open-stack policy, a Tower Room for recreational reading, and smoking permitted in some of the reading rooms. The walls of the Reserve Room are

decorated with the famous murals by the Mexican artist Orozco. Covering three thousand square feet of wall space, the murals use the Aztec legend of Quetzalcoatl, the Great White Father, to depict the story of civilization on the North American continent.

Baker Library, with its white Colonial spire, dominates the campus. Except for some of the earlier buildings, the Dartmouth plant is of Georgian Colonial design. It spreads out over 175 acres of a plain on the east bank of the Connecticut River, dividing line between New Hampshire and Vermont. The college is excellently equipped in its phyiscal plant of fifty modern buildings, valued at more than ten million dollars. Total assets of the college also include endowment funds of twenty-eight millions.

Winter Sports

The north country location of the college has fostered a distinctive sort of undergraduate life that has led to the widespread associating of Dartmouth's name with outdoor life and winter sports. The major extracurricular activity on the campus is sponsored by the Dartmouth Outing Club, which offers a varied, year-round program that takes advantage of the magnificent natural environment of the college. The club maintains a chain of eighteen cabins and additional shelters, extending from the Vermont hills, just across the river, through the White Mountains to the Dartmouth College Grant of 27,000 acres 140 miles north. Over one hundred miles of mountain trails are also maintained, and at Mt. Moosilauke, called "Dartmouth's Mountain" because the college owns the peak and one whole side, the D.O.C. operates the Moosilauke Ravine Lodge, a huge rustic camp where meals and lodging are available to the public as well as to Dartmouth men. Just this year Dartmouth has inherited from one of her graduates the summit of Mt. Washington, highest point in New England, and the famous cog railroad that runs up one side of the mountain.

The Dartmouth Winter Carnival, a spot of relaxation between semesters every February, is sponsored by the Outing

The Dartmouth College Campus

Club, and so is the Dartmouth ski team, which for many years has been pre-eminent in this increasingly popular sport. The selection of six Dartmouth men for the 1952 U. S. Olympic ski team is striking evidence of the place that skiing holds in Dartmouth's extracurricular life. Nearly every major college acquires some sort of trademark or distinction in the public mind, but it is doubtful if any other institution has ever been accorded virtual ownership of a season as has Dartmouth with respect to winter and the outdoor sports that go with the season of snow and ice.

No description of Dartmouth should close without mention of the nationwide organization of alumni that has become one of the college's greatest assets. One of the pioneer achievements of Dr. Tucker's administration nearly sixty years ago was to assign to the alumni a central and serious role in the work of the college.. On this foundation Datmouth has built steadily and with great success, so that every year more than a thousand graduates serve in official and semi-official capacities, while the rank and file of the 25,000 alumni render a continuing support without which Dartmouth could not have reached its prominent place in American higher education. The work of the alumni has been especially effective in the Selective Process of Admission, under which they handle the entire interviewing job, and in fund-raising. The Dartmouth Alumni Fund this past year raised $577,000 from 15,400 contributors. The percentage of alumni giving to the annual fund—this year's record was 65 per cent of all graduates and non-graduates—gives Dartmouth unchallenged first place in this aspect of alumni support.

The intense loyalty of Dartmouth men is ascribed partly to the north country location of the college, where the comparative isolation, the traditions, the masculine, outdoor life, the concentration in the college itself, all contribute to a unique and lasting spirit. Members of the American Society of Engineering Education, visiting the quiet New England village of Hanover next June, may wonder whether this can all be truly so, but for Dartmouth men everywhere it is one of the certainties of life.

Summer Schools

The Executive Board of the ASEE has authorized sponsorship of summer schools proposed by the Electrical Engineering Division and the English Division. Both summer schools will be held at Dartmouth College preceding the Annual Meeting.

The theme for the Electrical Engineering Division Summer School will be "Undergraduate Teaching of Electrical Circuits and Fields." It will be held on June 20 and 21, 1952, and the registration fee will be $1.50. For further information, address Dr. J. D. Ryder, Electrical Engineering Department, University of Illinois, Urbana, Illinois.

A summer school on Sanitary Engineering has been proposed by the Civil Engineering Division.

"What Type of Training Should Industry Provide for Co-op Engineering Students?"*

By THOMAS HAND

Acting Head, Research Dept., Corhart Refractories Co., Louisville, Ky.

I had the fortunate experience of attending an engineering school that was one of the pioneers in the co-operative plan of education. Having completed the required four years in the "salt mines"—one of the years being devoted to participation in the co-operative plan—I was fortunate in rising to a position with my company, in which I employ and supervise co-operative students from my alma mater.

Unfortunately, all my industrial co-operative work was limited to one company and all my experience in supervising co-op engineering students has been with the same company. Thus, I can not be sure that our own plan will fit other industries.

I can't help thinking back to my school days when my fellow classmates would gather in bull sessions and swap experiences concerning their co-op jobs. At that time—the late 30's—co-op jobs were often considered simply as a source of cheap labor for the Louisville area. Wage rates of 25 cents to 50 cents per hour were common, and the type of work performed was common labor, severely lacking in engineering aspects. This sort of thing was, at that time, quite permissible; shop unionization had not taken place to any major extent. Those were the days when supervisors were a part of the working force, and it was sometimes difficult to draw a line between management and labor.

Today, the pendulum has swung to another extreme. Most labor unions look upon the presence of the co-op engineering student as an infringement upon their private rights; any position held by the co-op student takes bread from the mouth of a union member. This has been a deterrent to the co-op engineering program and has limited its actual use in many training programs. Attempts are now being made by several companies in the Louisville area to correct this fault. My own personal feeling on the subject is that the young engineer misses a lot if he does not have the experience of working with his hands in industry before assuming a more responsible position.

Learning by Doing

There are two views on this problem: First, there is the old school view, which is based upon "learning by doing" and which, incidentally, is the plan usually followed by the engineering school in requiring a student to perform laboratory experiments. I have never found a better training method than the old "do! do! do!, get your hands dirty, dig into the thing, find out what makes it tick" type of thing. Experiences of this sort can never be obtained at a school or office desk. For example, you can read all you want about the operation of a metal cutting lathe, but you'll never know its real use and limitations until you get your hands on

*Presented at the Midwinter Meeting of the Cooperative Education Division, ASEE, at the University of Florida, January, 1951.

one of the things and actually perform the operation

Now, let us consider the other view on the problem. If we are prevented from allowing the co-op engineering student to work in our manufacturing facilities, the only other positions that could offer the essential training are in the laboratories and engineering offices And even the laboratory, in certain industries, comes under the control of the local labor union and is thus eliminated as a training ground. In this respect, we are limited in applying the technique of "learning by doing." Therefore, we must educate our students, by book learning and conference discussion techniques.

In developing a program of co-op engineering training, let us first set down the ideal program; then discuss a practical application of that program

Where do our engineers usually wind up their careers, say 30 or 40 years after graduation from school? It goes without saying that the majority of engineering graduates wind up their careers in executive positions somewhat above the factory supervision level. Thus our training program should be similar to that of executive training and also supply the technical applications of engineering. The two must go hand in hand. If we slight one in favor of the other, we may bend the twig in the wrong direction A balanced program taking into account both these requirements would be ideal. The following program combines engineering training and executive training:

Engineering Training

1. Skills of the Industry
2. Related Training
   a. Math and Shop Problems
   b. Science of the Industry
   c. Blueprint Reading
   d. Product Knowledge
   e. Manufacturing Processes
   f. Maintenance of Equipment
3. Job Methods
4. Safety and Housekeeping
5. Waste Elimination
6. Engineering Economy
7. Research—New Products
8. Research—New Techniques
9. Sales Techniques

Executive Training

1. Human Relations
2. Company Policy
3. Company Morale
4. Job Relations
5. Promotion Opportunities
6. Labor Relations
7. Economics
8. Business Ethics
9. Safety Standards
10. Labor Contracts
11. Law (Corporation and Labor)
12. Forecasting New Developments
13. Research Methods
14. Public Speaking

Subjects in this program have been arranged in the order of their importance. Theoretically, all should be given to an engineer who will eventually hold an executive position. Naturally the two areas should be sandwiched together in outlining the actual program.

To give the co-op engineering student a thorough training in all these subjects in his alloted time would be impossible. As a matter of fact, it requires a lifetime to become proficient in all these phases of management. But I set out to outline an ideal training program and this is it.

Ideal Program in Practical Form

Now, let me take this ideal program and try to fit it into a practical, useful form. In developing a practical program we must first make some assumptions. This program is designed to fit a small to medium-size industry with, say, less than 1000 employees. In industries of larger size there is usually a full-time training program functioning, which can easily be adopted for co-op engineering training. Here, I think, we are concerned with the average company where full-time training programs are not always feasible.

Generally speaking, in smaller industries four departments require some type of engineering skill: Production, Engineering and Maintenance, Development and/or Research, and Sales.

Let us assume that we are going to start with a co-op engineering student who has not yet had any industrial experience and develop a well-rounded program of training for him. This student has probably just finished his basic studies in mathematics, chemistry, and physics. He has been oriented to think of things in scientific terms. He may have an idea that all that is necessary to solve a problem in industry is to set up a mathematical equation or possibly a physics experiment, collect the data, set them into the proper pattern, and get the answer. Problem solved! Next problem. Simple, isn't it? Let's not kid ourselves; I know. I went through that stage, and the majority of students go through the same stage.

Now this could be a definite detriment to co-op training if it is not fully realized and corrected as soon as possible. First impressions are difficult to eradicate. It is not necessarily the fault of the school: these boys have been sitting at a desk for eight hours a day, five or six days a week, for at least one and usually two years. They have had theory, pounded into their heads until it runs out their ears. Then all of a sudden comes a sad awakening: the realization that it's not so easy to apply all these theories to actual problems and make them work as they may have been led to believe by the textbooks and their professors.

Where to Start

Our student is an individual—full of science and extremely anxious to put it to some practical use. Where shall we start him off to lessen his suffering when the light finally dawns?

Looking over the four basic engineering departments, we find that development, control, research, or one of their related components would be the most likely choice. Here would be the department to apply most directly the basic engineering fundamentals in which the student has had his training

A typical first quarter training program might take the following form:

Development—Research—Control
Typical examples:

1. Control work on process or product.
2. Routine testing of product.
3. Physical measurements on new products.
4. Preparation of laboratory samples.
5. Gathering data from experiments.
6. Gathering data from records.

Now that our co-op student is located, we are ready to discuss his duties within the department. This program will have to be quite general, because every industry is different—at least to some degree—in its manufacturing processes. In the majority of laboratories, certain routine control duties in some way reflect their findings toward control of the product or process being carried on or produced in the manufacturing department. This, we feel, is an ideal location to begin a co-op training program. There is usually a simple "cookbook" technique that has been repeated daily for many years We know its limitations from past experience and usually take the results from the control operation with a grain of salt for a short time until our student has mastered the necessary technique. Shortly he will be able to turn in reliable and dependable results.

Another caution we consider important is the choice of the particular student for certain operations. If the control operation is fundamentally based on physics, we normally expect new co-op engineering students from any branch of engineering to perform satisfactorily. However, if the operation happens to be chemical, such as a chemical analysis, we are most cautious whom we might pick to fill the job. In the past, we have noted resentment when we asked mechanical or electrical engineering students to perform chemical operations. This should be avoided in the initial stages, if possible. Let us not forget initial impressions; they may come back to haunt us later.

Along with such control work, we suggest frequent trips into the production

department with a trained man familiar with the process. If meetings are held in the student's department on topics that are of some value—yet not confidential—we find it best to admit the student as an observer. He should not take active part in the discussion until at least his second quarter of co-operative work has been completed.

After one quarter of co-operative work, we feel that the student should be sufficiently oriented in industrial procedure. He no longer needs to be babied but can be given projects not necessarily in his chosen line of engineering. We feel that approximately 75% of the student's time should be spent in performing his regular job and the other 25% should be given over to plant inspection trips, discussion of processes, or problems in the industry.

As for human relations, we do not stress this point too much during the first co-operative period, for two reasons: (1) the student himself is going through a drastic change, and (2) we are also getting acquainted with him and his peculiarities.

During the second quarter of co-operative work, we usually try to acquaint our students with our plant engineering and maintenance departments. If the student is scientifically inclined, we usually allow him advanced training with the development, research, or control departments. A typical program for the second quarter might take the following form:

Plant Engineering and Maintenance
Typical examples:

1. Drafting
2. Plant Layout and Planning
3. Testing of New Equipment
4. Maintenance of Production Equipment
5. Blueprint Checking
6. Simple Equipment Design Problems
7. Bill of Materials for Construction

Development, Research, Control
Typical examples:

1. Research project operator
2. Special development problems
3. Production problems
4. Time Study
5. Patent Research
6. Library Research
7. Construction of Laboratory Equipment

Human Relations Training

During the second quarter, we begin our human relations training. The student is invited to attend supervisor meetings and allowed to become a member of the Company Management Club, which holds monthly dinner meetings away from the plant. The student is given the opportunity to meet the operating staff. His work is so assigned that he must make contact with individuals or groups in order to advance. For example, if the student is assigned to the engineering department, he must make frequent trips into the plant in order to obtain dimensions for drawings of construction projects. Usually he needs some help. He must go to a foreman of the construction or maintenance crew, who in turn assigns one of his men to aid in obtaining the necessary dimensions. In other words, we force the student to make personal contact. If the student is placed on library or patent research work, he must hold frequent discussions with whoever is in charge of the project.

Only rarely is a student allowed to work alone or to lead a project during his second or third co-operative period. However, we have had students—particularly in the electronic field—who were more advanced in their type of work than any of our staff. In such case, we would outline the project, give the required result, and put the student on his own. Meetings are held on each project two or three times a week, and members of the staff are asked to discuss the project with the student. Believe it or not, sometimes the staff members get a liberal education from the student. This association with students keeps the staff members on their toes and encourages them to keep abreast of recent developments.

During the second quarter, the student is encouraged to keep accurate records

of his findings, if his position calls for such records. Each project is brought up to date in the form of a written report at least once a month. When a project is completed, a final report is written and presented by the student. This gives the student the feeling of having contributed to the organization.

Shift Within Production Department

If the student returns to the Company for his third period of co-operative work, it usually means that he is "on the inside." He is probably well liked and quite capable of fitting into the organization. The third quarter is usually spent with the production department. Typical examples of such work are:

Production Department
Typical examples:

1. Time Study
2. Record Clerk
3. Assistant to Department Supervisor
4. Special Production Problems
5. Observer for Quality Control
6. Order Checking before Shipment
7. Inventory Control
8. Stock Room Clerk

The student should be shifted from one job to another during his three months employment in the production department to give him the opportunity of meeting and working with many people. One month is usually the maximum time he spends in any position. He receives training in labor relations, the labor contract, how to give orders, how to discipline employees, personality development, how to work with people, and numerous other humanics necessary to the position he may hold.

If the student passes through the production period with honors and chooses to return to the company for his fourth and last co-operative period, he is usually given training in the sales department. A typical schedule of such training is as follows:

Sales Department
Typical examples:

1. Drafting
2. Equipment Design
3. Product Installation Drafting
4. Product Design
5. Bill of Material Preparation
6. Field Trips
7. Customer Contact
8. Observer of Product Installation

Usually the personality of the student must be fairly well developed by this stage of the training program. He is given every opportunity to work out complete problems by himself, then discuss his work with his superiors. Report writing is emphasized; all customer contact and field trips must be reported in detail. He is instructed in the use of company records and where necessary information can be obtained.

Key Positions Filled by Former Co-op Students

Our experience with this type of program has been very satisfactory. We are most appreciative of the opportunity to have students work with us; we all profit from the experience. Several key positions with the company are now held by men who originally entered our employment through the cooperative plan. It has the distinct value of allowing us to screen people thoroughly. Sometimes we purposely throw stumbling blocks in their paths so that we may observe their technique in solving knotty problems. If they make the grade, they are the men we are looking forward to having as key figures in our organization.

In preparing this talk, I requested the opinions of several co-operative students on what they wanted to get from their co-operative work. You might be interested in their side of the problem. Here is a list of the high points they would like to stress in their training work:

Contacts with industrial relations
Personality in supervision
Leadership in training

Opportunity of gaining respect of their superiors
Discipline
Cooperation
Orientation
Working with people
Facts and figures
Concrete examples of industrial economy
Cost economy
Engineering economy
Practical engineering experience
Typical engineering problems
How to think
Hard work and plenty of it

College Notes

To meet the increasing demand from all types of planning agencies for engineers who have knowledge of planning methods and techniques, the College of Engineering at **Rutgers University** will offer for the first time in September 1952 a curriculum leading to the degree of Bachelor of Science in Planning Engineering. The new program will incorporate courses in city and regional planning with a basic core of engineering subjects. The city and regional planning sequence may be taken not only by engineers, but also by students majoring in Economics, Sociology, and Political Science. Thus, Rutgers will bring together in the planning courses students representing the major fields which are involved in planning operations.

Harold L. Hazen, Head of the Department of Electrical Engineering at the **Massachusetts Institute of Technology** since 1938, will become Dean of the Institute's Graduate School next July, James R. Killian, Jr., President of the Institute announced. Harold Hazen will succeed John W. M. Bunker, who has been Dean of the Graduate School since 1940. John Bunker, who joined the Institute's staff in 1921 as an assistant professor of physiology and biochemistry in the Department of Biology, will retire at the end of the academic year.

Professor Frank A. Record has been appointed chairman of the electrical engineering department at **Clarkson College** and Dr. Theodore S. Renzema has been named chairman of the physics department.

The Board of Education of **Wayne University** announced the acceptance of grants totalling $200,000 from General Motors Corporation and the Ford Motor Company for expansion and maintenance of the large-scale computing machine laboratory at Wayne University.

A grant of $400,000 to the **Massachusetts Institute of Technology** from the Edwin Sibley Webster Foundation to establish an Edwin Sibley Webster Professorship of Electrical Engineering was announced by Dr. Karl T. Compton, Chairman of the Corporation of the Institute.

Determining Teaching Objectives

By FRANK KEREKES

Assistant Dean and Professor of Civil Engineering, Iowa State College

Today a great body of men, including those outside as well as inside of educational circles, has arrived at the important conclusion that there is but one unified fundamental objective for higher education in a democracy. This objective is achieved when through the processes of higher education young men and women develop their intrinsic abilities to perform, in a creditable manner, the work they want to do and to integrate, through service, their lives with those of the other members of their community, State and Nation.

Twofold Objective of Engineering Education

In order that engineering students may attain this fundamental objective their education must be planned to enable them to enter the engineering profession not only proficient in the scientific-technological areas of subject-matter but also well founded in the humanistic-social areas of relationships with society. With objectives clearly developed in these two areas the engineering educator has at his disposal the material upon which he can base essential teaching objectives.

The objectives of the scientific-technological and the humanistic-social areas are the end results in subject-matter which the students should possess in proportion to their capacities to benefit from education.

The teaching objectives are the end results which the students should acquire in the development of their mental power, personal attitudes, and habit formations as a result of the efficiency and effectiveness of the contacts with the members of the faculty.

Each and very course should be so planned and so conducted by the teacher that the students are progressively nearer to the achievements of the scientific-technological and humanistic-social objectives because the qualified teacher is progressively achieving the end results set forth in his teaching objectives.

Objectives of the Humanistic-Social Stem

On the one hand it should be clearly understood from the beginning that the scientific-technological stem applies only to the designation of the type of work and nature of thought and approach to a problem which sets the professional engineer apart in his community. On the other hand, the humanistic-social stem should be common to all men benefitting from the opportunities implied in higher education.

The humanistic-social area of higher education and its subsequent application provides the universal medium in which man must function as a member of society. It is the medium in which each of us contributes our worth to the functioning of the community in which we live, be it the home town, the State or the Nation; it is the medium in which each of us participates and shares in the integrated worth of the entire community.

We, as engineers, must give to as well as take from the benefits of our environment. The development of the humanistic-social consciousness of the individual, be

he business man, or doctor, or lawyer, or public official, or craftsman, or engineer, provides him with the fundamental prerequisites to enjoy the privilege of serving and being served by the members of his community; provides him with an understanding of his own problems and aspirations in terms of the problems and aspirations of others in his community; and, finally, provides him with the power and satisfaction that comes from the realization that he is carrying his full share of the responsibilities of community participation, cooperation and leadership in compensation for the privilege of being an educated man as well as a respected and proficient engineer.

"Humanistic-social thought dealing with the moral, ethical and political aspects of man and his institutions seeks to question situations, to phrase problems, to gather evidence, to weigh values, to make judgments and to direct conduct. It is subjective, qualitative, and seldom free from preconditioned emotional attitudes. Its pursuit in an atmosphere of neutral detachment is practically impossible. Conclusions are usually in terms of good or bad, right or wrong."

The 1940 report of the Committee on Aims and Scope of Engineering Curricula gives the following statement of objectives for the humanistic-social stem:

1. Understanding of the evolution of the social organization within which we live and of the influence of science and engineering on its development.

2. Ability to recognize and to make a critical analysis of a problem involving social and economic elements, to arrive at an intelligent opinion about it, and to read with discrimination and purpose toward these ends.

3. Ability to organize thoughts logically and to express them lucidly and convincingly in oral and written English.

4. Acquaintance with some of the great masterpieces of literature and an understanding of their setting in and influence upon civilization.

5. Development of moral, ethical, and social concepts essential to a satisfying personal philosophy, to a career consistent with the public welfare, and to a sound professional attitude.

6. Attainment of an interest and pleasure in these pursuits and thus of an inspiration of continued study.

Objectives of the Scientific-Technological Stem

According to H. S. Rogers: "Scientific-technological thought dealing with nature and her forces makes an effort to observe, to describe, to classify, to analyze, to explain and to use constructively. It is objective, quantitative and logical and is pursued in an atmosphere of neutral detachment. It may be applied in certain humanistic-social studies as for example in the field of economics. Conclusions are usually in the terms of truth or falsehood. This stem deals with objective realities.

"Conclusions are accepted tentatively. We speak of principles and laws as truth with full realization of the fact that they are conditioned by the present state of knowledge. We utilize principles which we know to be inaccurate because they are currently the most useful tools available for the solution of practical problems. Knowledge is considered progressive and the current state approves and accepts, or corrects and amends the earlier."

The Report of Committee on Aims and Scope of Engineering Curricula, Dean H. P. Hammond, chairman, contains the following specific objectives for the scientific-technological stem:

1. Mastery of the fundamental scientific principles and a command of basic knowledge underlying the branch of engineering which the student is pursuing. This implies:

a. Grasp of the meaning of physical and mathematical laws, and knowledge of how they were evolved and of the limitations in their use; and

b. Knowledge of materials, machines, and structures.

2. Through understanding of the engineering method and elementary competence in its application. This requires:

a. Comprehension of the interesting elements in situations which are to be analyzed;
b. Ability to think straight in the application of fundamental principles to new problems;
c. Reasonable skill in making approximations, and in choosing the type of approach in the light for solution—in sum, a foundation for engineering judgment;
d. Resourcefulness and originality in devising means to an end;
e. Understanding of the element of cost in engineering and the ability to deal with this factor just as competently as with technological factors.

3. Ability to select the significant results of an engineering study and to present them clearly and concisely by verbal and graphic means.
4. Stimulation of a continuing interest in further professional development.

Differentiating Characteristics of an Engineering Curriculum

The Institute of Civil Engineers was founded in 1828 in London. On a subject-matter basis this one society sufficed the common technical and professional needs of its members. Even as late as 1852 when the American Society of Civil Engineers was founded one society offered the ncessary and sufficient service to engineers of that era. Since then there were founded what we call the principal branches of engineering such as mechanical, mining and metallurgy, electrical, chemical. Since 1900 these principal branches began to sprout twigs, twigs that in many instances have grown into branch size. Civil engineering, for example, also is represented by the American Railway Association, the American Concrete Institute, The American Waterworks Association. The same subdivision on a subject-matter basis is taking place in other engineering societies.

On the one hand this trend in specialization continues as the subject-matter knowledge grows by leaps and bounds in every particular area of application. Furthermore, this trend in engineering specialization will continue to form new groups which will devote themselves to ever narrower fields of subject-matter in terms of basic scientific fundamentals, new technological science, technological empirical data, practical applications, and engineering experience.

On the other hand engineering education must continue to emphasize the attainment of the objectives common to all engineering. Because specialization is the natural and logical trend in engineering practice it becomes all the more important for the engineering educator to determine the basic objects by which to prepare men for broad responsibilities of the engineering profession, for rigorous intellectual requirements, for professional attitudes toward and habits of work, and for attitudes toward people, life and professional standards. In order that the students may achieve these ends the engineering educator needs to formulate specific teaching objectives and techniques.

In an effort to include only those characteristics of the responsibilities of an engineer which clearly differentiate his education, knowledge and training from those of other professional men, Dean S. C. Hollister in behalf of the Committee on Engineering Schools of the Engineering Council for Professional Development formulated, in October, 1949, a statement that will in all probability be acceptable to most engineering educators and to practicing engineers. He proposes that

"An engineer is characterized by his ability creatively to apply scientific principles to design or develop structures,

machines, apparatus or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design, and of the limitations of behavior imposed by such design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation, and safety to life and property."

The engineering educator is challenged to formulate teaching objectives that will apply to the education of all engineering students regardless of the special field of engineering they may choose to follow. These teaching objectives must be related to the functioning of thought, to the strengthening of character, personality and ideals, to the establishment of ethical, moral and political values, and to the development of effective habits of behavior and work. The purpose of these teaching objectives, then, will be achieved in proportion to the individual student's capacity for development and to the individual teacher's skill in the art and science of engineering and education.

First Objective

The engineering curriculum is the prescribed course of study, a framework, within which all the subject-matter objectives are to be achieved. There then follows

TEACHING OBJECTIVE ONE: To design a curriculum which will include only those courses that are fundamental to every branch of engineering, that are basic to the particular curriculum of specialization, and that are generally useful to an educated person.

Objective One will be achieved when each teacher, in collaboration with his associates, arrives at acceptable answers to the following questions in terms of the conditions expressed in Teaching Objective One:

a. What are the basic courses in the humanistic-social stem including English, literature, history, economics, psychology, and human relations essential to the pursuit of engineering work and to the participation in community responsibilities?

b. What are the basic courses in mathematics, chemistry, physics, geology and biology essential to the development and understanding of the fundamental technological sciences—statics, strength of materials, dynamics, fluid mechanics, thermodynamics, electronics, aerodynamics, and soil mechanics?

c. Which of the technological sciences are common to all branches of engineering and which are necessary to the specialized branches of engineering?

d. Which applied technological courses are absolutely essential adequately to prepare a student for entering his chosen branch of engineering?

e. How far shall the engineering colleges go in designing special curricula for offshoots from the established major branches of engineering? That is, shall engineering educators design complete curricula in Construction Engineering, Radio Engineering, Foundry Engineering, Welding Engineering and the like?

Second Objective

The individual courses in each curriculum are the mediums in which the manipulative techniques, knowledge, fundamental theories, and technological practices and standards are learned by the students. Furthermore, and importantly, these individual courses offer the mediums for direct student-teacher contacts. These lead to

TEACHING OBJECTIVE TWO: To *develop* in each course *the abilities* which each student should acquire and improve.

Objective Two will be achieved when each teacher will formulate his answers to the following questions:

a. What *manual* and *operating skills* are absolutely essential in future courses and later engineering practice?

b. What basic *knowledge*—generic principles, simplifying assumptions, empiricisms, derived principles and working

formulas, and specifications and codes of practice—should be included as the minimum requirement for subsequent use by the student in college and in engineering practice?

c. What opportunities does the course offer for the exercise and development of *reasoning power* which will enable the student to arrive at correct conclusions which can be verified?

d. How can the exercise of *judgment* be introduced throughout a course so that the student may make tenable decisions and choices based upon previous experiences in work, theory and application? These judgment decisions are made without formal process of solving the problem. Since judgment is based on past experiences the mind rapidly associates the new situation with similar situations in the past and arrives at a selection, choice, conclusion or solution.

e. What opportunities does the course offer for creative thinking by the student?

Third Objective

In commenting on who is a good teacher, W. H. Lancelot concludes, "Indeed, most of us will agree that the deepest currents of our lives have been turned and strengthened by our really good teachers; and most of us know full well which ones exercised this fateful, yet beneficent, influence over us. How they accomplished these things is probably not clear to us even yet. We can see, however, that the skill which they possessed was of a strange order. It was unlike the skill of the surgeon, or the engineer, or the scientific investigator. It may even appear to have been a higher order of skill than any of these processes; and this may be true, since teachers deal not only with processes of life and nature, as do they, but with things that are even *less tangible and predictable* and that are *harder to control,* such as mental activity and human emotions."

Certainly, those teachers who are considered to be good by generation after generation of students must possess a skill in the art and science of teaching on a scale comparable to the skill of the eminent lawyer, doctor, engineer, minister or business man. The recognition that there is a science to teaching leads to

TEACHING OBJECTIVE THREE: To *master the teaching skills* whereby the objectives of the curriculum as a whole and of each course as a unit may be achieved in a positive manner by the students.

The teacher will achieve this objective when he perfects his skills in motivating his students to take full advantage of the opportunities offered in each course for the development of their manual, mental, moral and social capacities.

To acquire and to improve these teaching skills and thereby to achieve Teaching Objective Three each teacher must devote careful and intelligent effort in answering the following questions.

a. What are the principles of arousing genuine interest and how can these principles be applied in each course?

b. How can the students be stimulated to strive toward high ideals and mature purposes?

c. What techniques are available to the teacher so that his students will gain a true relationship between new facts, theories and principles and those already experienced? How can the ability to understand be stimulated and strengthened?

d. What are the techniques by which the abilities, namely, manual skill, basic knowledge, reasoning, judgment and creative thinking, may be put into action spontaneously as they are needed by the students?

e. What means are available to the teacher to bring about those emotional responses and attributes which give the students the urge toward high and worthy professional and community achievement?

Fourth Objective

Perhaps the most characteristic function performed by the engineer is that

of solving problems. In the solution of his problems the engineer employs a definite sequence of thought and a special body of knowledge based upon facts and principles which have been classified as follows in the 1944 Report of Committee on Engineering Education After the War:

1. *Generic Principles* of the fundamental sciences.
2. *Basic Assumptions* which are made for the purpose of simplifying the conditions of the problem and the related mathematical solution of the physical phenomena.
3. *Empiricisms* such as physical constants and properties of materials which have been observed and measured in the field or in the laboratory.
4. *Derived Principles* forming the theoretical and fundamental background for the applied engineering practice.
5. *Specifications, standards and codes* which represent the engineering profession's accumulated experience in analysis, design, production and construction.

Since the ability to solve problems involves a tremendous amount of operating skill, theoretical and empirical knowledge, reasoning power, judgment decisions, and creative thinking, it seems reasonable to set up

TEACHING OBJECTIVE FOUR: To *prepare problems* whereby the student may test his powers of applying engineering thought and practice in terms of the fundamental abilities that typify the thinking processes.

To achieve this objective the teacher should be prepared to answer the following questions relating to the design of thought-provoking rather than memory-testing problems. It has been said that "Where there is no thinking there is no learning; where there is no learning there is no teaching."

a. What are the distinguishing characteristics of good problems?

b. How can problems be designed so that the objective is the solution and not the mere repetition of memorized facts and procedures?

c. Should problems preferably reflect actual life situations?

d. To what extent should simplifying assumptions be introduced?

e. Is it desirable to select concrete problems to which knowledge, previously acquired, may be applied? (Deductive)

f. How can problems be designed to assist in the understanding of knowledge? (Why, causes, reasons, explanations)

g. How can problems be used to establish new facts or generalized truths? (Inductive)

Fifth Objective

In addition to the mastery of knowledge and development of the power of constructive thinking there should be a continual growth in the personality of the student. This goal leads to

TEACHING OBJECTIVE FIVE: To bring forth and strengthen the personality traits of each student in terms of personal effectiveness whereby each student may succeed intellectually and in terms of social effectiveness whereby each student becomes appreciated and respected by his associates.

To achieve this objective the teacher should study what techniques are available after he has determined the major personality elements of traits that make up personal and social effectiveness. These techniques should be applied throughout each course and paralleling all contacts with the students. He should develop answers to the following questions:

a. How can the following traits of personal effectiveness be developed in students while they are pursuing their regular course work?

1. Confidence	5. Enthusiasm
2. Initiative	6. Integrity
3. Thoroughness	7. Dependability
4. Industry	8. Accuracy

b. How can the following traits of social effectiveness be developed in stu-

dents while they are pursuing their regular course work?

1. Appearance
2. Physical vigor
3. Social qualities
4. Tact
5. Tolerance
6. Cheerfulness
7. Spirit of service
8. Emotional control

Sixth Objective

The engineering method of thought is generally explained as the differentiating characteristic of the approach and solution of a problem by an engineer in contrast to the approach and solution employed by others. Professor D. W. Mead has said: "The purpose of technical education is not so much to impart technical knowledge to the student as to furnish training which will enable him to think clearly and accurately,

a. To understand and investigate the conditions which surround a problem,

b. To determine the fundamental principles upon which its successful solution depends,

c. To ascertain and analyze the elements which influence or modify it,

d. To design the structures, machines, engines and works needed for its successful development,

e. To supervise the proper construction of such works and production of such machines, engines and equipment, and

f. To carry them to the consummation of a successful and economical completion."

These observations lead to

TEACHING OBJECTIVE SIX: To develop the ability to think well in both the scientific-technological and humanistic-social areas.

To achieve this objective the teacher should assimilate the basic principles of the laws of learning and he should apply these in all his contacts with students in the lecture room, design class, and laboratory. In preparing himself the teacher should seek answers to the following questions:

a. What types of problems and questions will stimulate alert association of the requirements of the new problem with previously acquired knowledge and concepts during each class period?

b. How can each assignment become either a problem-solving process or a process of organizing and interpreting qualitative and factual data?

c. How can the habits of the students be oriented and established by reaching an early inference as to the probable answer of the problem, by search for further available pertinent information, by arriving at a conclusion in agreement with the available data, and by testing the soundness and validity of the conclusions?

d. How can student discussion be motivated, sustained and directed?

e. Can students be trained to test their own conclusions?

f. How can clear thinking, accurate reasoning and sound judgment be introduced into student work and discussion?

g. How can the creative urge be awakened, directed and developed?

Seventh Objective

To do one's best there must exist an inward desire for improvement, achievement and service. Ideals are the prime motivators that cause men to contribute their skills and possessions for self-improvement and for the improvement of their social and physical environment. Therefore, there is needed

TEACHING OBJECTIVE SEVEN: To lead students to adopt high ideals toward their work, their thinking and toward their relationships with other men and groups.

The teacher may acquire the guiding principles to the stimulation of his students' desire to strive for ideals by arriving at conclusions or answers to the following questions:

a. What ideals does the teacher possess?

b. What are the motivating elements that cause students to respond to ideals?

c. Do interest in the subject and respect for the teacher contribute to the acceptance of ideals by the students?

d. Is there a limit to the nature of ideals which students comprehend? Are the ideals acceptable by Freshmen less challenging than those by Seniors?

e. Is there any relationship between the value of an ideal and the expenditure of thought, time, energy and expense to achieve it?

f. Can ideals be imposed or preached or must they be accepted by the free will of students on the basis of appropriateness and merit?

g. To what extent do feeling and emotion enter into the motivation of ideals?

h. Can the proper emotional situation be created for arousing ideals?

i. How can a student be led to the conviction that there is merit in an ideal so that he will spontaneously work toward the achievement of an ideal?

j. Are people likely to let others know about the ideals they have set for themselves?

k. How can ideals be kept alive and growing?

l. What approaches are available to interest students so that they will choose high ideals voluntarily and that they will pursue them intensely and continuously through their lives?

Conclusions

It is entirely possible to achieve the general purpose of education in engineering by emphasizing performance in work, power in thinking, and ideals in attitudes and in behavior.

The curriculum offers the framework for acquiring the mastery of knowledge in the scientific-technological and the humanistic-social areas of thought and action.

The method of teaching offers the framework for acquiring the power of constructive thought by students.

The power to think breathes life into the body of knowledge. The power to think is the chain-reaction of the mind whereby infinite applications can be made from a finite amount of knowledge. The power to think creates and extends the boundaries of knowledge. The power to think is life; the mastery of knowledge is substance. The two are inseparable. They exist together; they perish alone.

Thus the time is at hand when educators must rise to the challenge that there is a science and art applicable to teaching. Unless this science and art of teaching is applied to the development of the power in thought of students, the mastery of knowledge will be still-born and of little use.

Teaching Objectives

1. To *design a curriculum* which will include only those courses that are fundamental to every branch of engineering, that are basic to the particular curriculum of specialization, and that are generally useful to an educated man.

2. To *develop the abilities* (to do and and to think) which each student should acquire and improve in each course.

3. To *master the teaching skills* whereby the objectives of the curriculum as a whole and of each course as a unit may be achieved in a positive manner by the students.

4. To *prepare problems* whereby the students may test their powers of engineering thought and practice in terms of fundamental abilities that typify the thinking processes.

5. To *bring forth and strengthen the personality traits* of each student in terms of the personal effectiveness whereby each student may succeed intellectually and in terms of social effectiveness whereby each student becomes appreciated and respected by his associates.

6. To *develop the ability to think well* both in the scientific-technological and humanistic-social areas.

7. To *lead students to adopt high ideals* toward their work, their thinking and toward their relationships with other men and groups.

General Education in the Land-Grant Institutions

By EDMUND E. DAY

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Right at the start of our consideration of the subject before us on this occasion, a question of orientation needs to be raised: To what extent should general education in the land-grant institutions be different from general education in other types of institution?

In giving answer to this question, reference is bound to be made to the statement of purpose in the founding Morrill Act of 1862. This Act set up its large granted public lands for the endowment, support, and maintenance of at least one college in each state or territory where the leading should be "to teach such branches of learning as are related to agriculture and the mechanic arts." But other parts of that original statement of purpose are today of equal importance. Thus the Morrill Act stated explicitly that "other scientific and classical studies" were not to be excluded. Even more significantly, it concluded its declaration of purpose with these words: "in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

The "industrial classes" of 1862 were the farmers and laborers—the common folk of the time. What the Morrill Act undertook to provide for these people was higher education that was *both* liberal and practical. It was to be education fitting the common man for the "several pursuits and professions of life."

I question whether any broader charter for general education could have been drawn. True, as a matter of historical development, the land-grant institutions have stressed the practical, scientific and professional. But the charge under which they were established gave them educational responsibilities of a comprehensive character. This has been strikingly reflected in the more recent development of the land-grant colleges and universities. As matters now stand, it would seem perfectly clear that the land-grant institutions have the same obligations with respect to general education that other comprehensive institutions of higher learning have—perhaps no more but surely no less. It is on the basis of this conception of their function that I shall make my observations on what may be expected of general education in the land-grant institutions in this second half of the 20th century.

Interest in general education was never more widespread than it is today. This is true both inside and outside the teaching profession. Lay discussion of educational problems is reaching an all-time high. Part of this lay interest probably stems from a concern of parents over what appears to be happening to their own children. But a wider source of interest lies in an almost universal anxiety over the state of the world. Values we have long cherished seem to be in jeopardy. Established customs are being uprooted. Advancing technology is outstripping our means of social control. Divisive forces threaten our basic social solidarity. We have become more and more confused, uncertain and distrustful. We look about

for help. What more natural than to assert: Education should be contributing more than it is!

Capacities of Formal Education not Unlimited

It should be. But just what, and how? The capacities of formal education are not unlimited. Home and church share the responsibilities which school and college have to carry. Moreover, powerful influences, such as those exerted by movies, magazines, newspapers, radio, and now television, may adversely affect what formal education is trying to do. We are most likely to make formal education more effective if we recognize from the outset the bounds within which it has to operate.

Even with these limitations recognized, the role of formal education is tremendously important. The schools have possession of the nation's children and youth for a substantial part of their waking hours during most of the formative years of their lives. What the schools can do with this opportunity is immeasurably great. This is especially true in a period of turmoil and conflict. The responsibilities of formal education in America were never greater than they are right now.

These responsibilities can be spelled out in terms of the purposes of total education in a free society. If terms are kept general the present task of education can be described in a number of different ways. We may speak of the task as one of transmitting the cultural heritage. We may refer, on the other hand, to the job of promoting the greatest attainable individual growth and development. Or we may cite the necessity of inducing an adequate individual and collective discipline of body, mind, and spirit. We may spell out the human traits, relationships, and organizations requisite to the preservation of freedom. We may specify the social arrangements and controls demanded by advancing science and technology. These and other identifications of the task of education in a modern free society advance ideas which are certainly germane to the shaping of formal education for the kind of world in which we now live. However, they all have the same deficiency. They leave wide open the problem of formulating concrete educational programs.

Obstacles

The translation of general educational purposes into specific school and college programs encounters all sorts of obstacles. Three sources of chronic difficulty may be cited: (1) disagreement as to the nature of the learning process; (2) competition of specific educational interests; and (3) excessive generality of statement in the formulation of objectives.

The extent to which learning should be sought through the exercise of arbitrary authority by the teacher has been a subject of dispute among both educators and laymen for generations past. The debate has become somewhat acrimonious in recent years. The progressives have urged the importance of making materials and methods "meaningful" to the learner. The conservatives have stressed the necessity of class-room discipline. On balance in the dispute, the importance of learner interest has been increasingly recognized. In due course, as views become less extreme and educational research makes further progress, this area of disagreement promises to assume less formidable proportions.

A competition of interests lurks in every educational program. Demands have to be compromised and brought into some sort of balance. The essentialists clamor for more attention to the "3 R's" while others urge the necessity of widening the range of the learners' interests and appreciations. The vocationalists play upon the natural concern of youth with that first job and jam the program of instruction with technical offerings. The corrective for all this is a comprehensive view of the relative importance of values to be sought through total education. Such a comprehensive view is an essential of

educational statesmanship. The broad view cannot easily be had but if achieved will resolve many of the most serious conflicts with which formal education in recent years has been afflicted.

Excessive generality of terms is a persistent ailment of statements of educational goals. Thus it is all very well to state that it is the job of education to produce the "good citizen," or the "extraordinary American," or to prepare young people for "wholesome home and family living," or to induct those who enjoy freedom into the "good life." The trouble with such statements, clearly enough, is that they can "mean all things to all men."[2] Hence they do not start anything. Statements of educational purpose should stir people. If they do not prove controversial the chances are they are too general. In other words they are not sufficiently specific. A higher order of specificity is the crying need of current discussions of the purposes of education.

Educational Objectives

There are those educators who will contend, ordinarily with some show of impatience, that it is a waste of time to talk any more about educational objectives. The idea is that all that can be said on the subject has been said, or that consideration of this particular aspect of education has passed the point of profitable return. I am myself convinced that this is not at all the case. We are still very much in need of a more incisive discussion of just what we are trying to do educationally.

It is as if we were navigating at sea. It made sense for Columbus to set sail with no more definite idea than to sail west. But what shipper, unless on pleasure bent, would sail out into the ocean today without a definite country or port of destination? Furthermore what captain of a ship would sail without knowing the means by which to guide his course? It is high time that education charted its course more specifically.

There are at least three different approaches to the analysis of educational objectives. We may think in the first place in terms of the physical, intellectual, emotional and motivational growth, and maturation of the individual. Or we may recognize the various roles or functions of the individual in society; as consumer, producer, home-builder, parent, neighbor, citizen—of the local community, the state, the nation, the world—and as an integrated person seeking the "good life." Or instead of these approaches we may come at the analysis of objectives in terms of specific outcomes: interests, skills, knowledge, understanding, attitudes and ideals, habits. It is my considered opinion that this third approach is the one most likely to prove fruitful, keeping in mind all the time the various roles the individual will be called upon to play.

Let us agree then, at least for the present discussion, that it is the job of total education to: (1) arouse interests; (2) develop skills; (3) convey knowledge; (4) impart understanding and appreciation; (5) establish attitudes and ideals; and (6) cultivate habits. We are then faced with very concrete questions. What specific interests, skills, knowledge, understanding and appreciation, attitudes and ideals, and habits are to be sought? Which of these are to be regarded as of most importance, which of lesser importance? What means, curricular and extracurricular are to be employed in the effort to secure the desired outcomes? These are some of the questions that have to be faced squarely and constructively if education is to render a greater total service in the present troubled world.

Lines Along Which Thinking Needs to Proceed

To pursue this line of thinking all the way through to definite conclusions would take a lot more time than is available on this occasion. All I can hope to do here is to suggest by way of illustration the lines along which thinking needs to proceed.

Take the subject of interests. One of

the earmarks of advancing civilization is a greatly expanded range of sustained interests. Primitive man was satisfied with little, modern man wants much. Many of his articulate wants relate to devices and implements of every sort. With reference to arousing interest in these material possessions, formal education needs to do little if anything. The advertisers take care of that. But what of interests in people, with special reference to the strikingly diverse conditions under which they live and strive? What of interests in art and the things that make for beauty in life? What of interests in the joys and satisfactions of the intellectual life? What of interests in the struggles and aspirations of the human spirit? The drives of materialism, opportunitism and provincialism are formidable in the world of today. Formal education is charged with the duty of doing all it possibly can to arouse interests that will combat these threatening forces of the current social order.

What of necessary skills? The three R's have, of course, long been recognized. In recent years, the importance of speaking and listening is being more and more stressed. In general the arts of communication are certain to be included in any listing of the skills to be cultivated through formal education. The problem here is not one of setting objectives but of raising the level of their attainment. The same is true of certain closely related goals having to do with the ability to think logically, objectively, reflectively, imaginatively, and constructively. There is a better training of the mind at all levels of native intelligence which is desperately needed these days. But these are matters with respect to which educators will not seriously disagree, at least so far as the purposes and ideals of education are concerned.

But what of certain other skills? Take, for example, those skills which relate to bodily controls and physical coordination. These certainly have their bearing upon the maintenance of physical health. And how about those skills which facilitate wholesome recreation; such as a well-grooved golf swing acquired at age 12! Should skills of this sort be of any concern to education.

Then there are those skills which have to do with sound human relations in a free society. How to get along amicably and effectively with others is a definite art. It varies with the degree of intimacy involved. Some individuals grow up exceptionally endowed for success in the practice of this art; others have to learn the hard way. But learn they can, at least in some measure, if they are wisely instructed. Skill in cooperation is an extremely important skill in a democracy such as ours. To what extent and by what means should formal education undertake to develop it?

Other Skills

Other skills that have to be considered fall into the field of the creative arts. There are latent possibilities along this line that have still to be fully explored. Then there are skills that many people need to acquire to achieve emotional stability. The requirements of mental hygiene become increasingly clear. Some involve skill in developing certain practices and avoiding others. Perhaps these are skills that lie beyond the reach of formal education, but the area is one that invites careful analysis.

Skills that have to do with specific vocations or professions fall outside the scope of general education, but are clearly enough recognized in total education. By and large, education succeeds remarkably well in developing these particular varieties of skill. In so far as deficiencies develop in this type of educational undertaking, they are likely to take the form of an unduly restricted conception of the skills the learner is likely to need later on in his working career, say, at age 45.

Let us turn next to knowledge as an educational objective. Here the basic question is: knowledge to what end? It may be contended that knowledge is an end in itself. Is it not true that "knowledge is power"? But education is pack-

with evidence that knowledge of the sort conveyed in class-room instruction is highly ephemeral, and quite commonly divorced from any subsequent behavior of the learner. The chances are that educational planning will be markedly improved if knowledge is regarded as a means to an end—the end being found in other desired outcomes of the total educational undertaking.

Even so the inculcation of knowlege as such remains a major educational objective. We therefore face the problem of deciding what knowledge to convey. Without attempting to give the whys and wherefores, I would myself identify the following subject matters for inclusion in the total program of general education:

1. The physical universe.
2. Human growth and development.
3. The Great Society.
4. The cultural heritage with special reference to the Judeo-Christian tradition.
5. The meaning and implications of Democracy on a world-wide scale.
6. Human relations with emphasis on moral and spiritual values.
7. The nature of knowledge and of its acquisition.

Whether or not knowledge in fields such as these has been actually imparted can be ascertained, of course, by appropriate testing. What is more, its retentioin can be encouraged by later examinations of a general or comprehensive character. This is one of the areas in which formal education can proceed with greatest assurance of success in attaining its declared objectives.

When objectives take the form of understanding and appreciation, and even more when they deal with attitudes and ideals, complicated value judgments have to be made and educational achievement becomes much more uncertain. Yet objectives of this more difficult sort must be recognized and set if education is to meet its responsibilities in a divided world. Time on this occasion does not permit any analysis of the specific aims which formal education should acknowledge in these areas in which esthetic, ethical, moral and spiritual values play a decisive part. However the supreme importance of concrete and unequivocal aims in these areas cannot be seriously questioned. For example, with respect to such matters as the inculcation of proper standards of honesty and personal integrity, formal education must take a positive stand. Just what measures can best be adopted to attain objectives of this character may be open to question, but refusal to accept responsibility for "character building" will not do. Nothing is more needed in educational planning these days than clarification of objectives in these areas relating to understanding and appreciation, attitudes and ideals, and habits tending to perpetuate good practices.

Points to Keep in Mind

May I conclude with the citation of four or five points which need to be kept constantly in mind in attempting to increase the effectiveness of general education.

The temporary acquisition of knowledge as such tends to get over-emphasized in formal education. The presentation of factual materials is the simplest type of teaching assignment, and the possession of knowledge at the point of examination is the easiest type of learning to measure. If instruction follows the lines of least resistance it will end in an over-done effort to convey knowledge. Other outcomes of equal and perhaps greater importance will thus fail to get the attention they merit.

Attempts to identify these other outcomes in concrete detail ordinarily result in a multiplicity of specific objectives. While all of these may be deserving, their very number serves to introduce a measure of diffusion if not of confusion, in the direction of educational activities. What is needed is a system of priorities. Certain objectives must be recognized as primary in importance, others as secondary or teritiary. It is hardly necessary to add that these ideas of relative importance may reasonably reflect the particular

needs of a given phase of political, economic, or social organization and development.

The potential impact of the *total educational enterprise* has to be considered in seeking the attainment of some of the objectives of general education. Extracurricular as well as curricular activities have to be brought to bear. Thus the operation of a student union or the promotion of an effective organization for student self-government may contribute significantly to the attainment of important skills and the establishment of indispensable attitudes and ideals. It is only through a consistent total educational experience that we can hope to reach certain of the goals of general education.

This points to the necessity of integration. Efforts to sharpen the objectives of general education, or in the wording we have previously used, to make them more specific—must not be allowed to result in any fragmentation of the educational program. Certain units of instruction may be required in order to pull things together. More essential, however, is an explicit educational philosophy governing the entire operation in all its parts.

Continuous Evaluation Necessary

Finally it is important to recognize the place of continuous evaluation. One of the strongest reasons for setting objectives more specifically is that only so are we in a position to measure the effectiveness of our procedures. We greatly need in education to know more definitely whether or not we are succeeding. We need to experiment with a better chance of knowing what results we are obtaining. Comprehensive and critical appraisal should characterize the whole process of seeking to achieve more fully the purposes of general education.

Total education, as the biggest single force in the development and conservation of human resources, has surpassing importance. For a world in conflict it becomes absolutely essential that this great force be given as sharp and sure a direction as educational statesmanship can achieve. Hence reexamination, reappraisal and redirection of the educational enterprise are all from time to time in order. They surely are in order right now. Basic planning activities of this sort have had too little attention. It is high time that the institutions in this Association made such planning a matter of major concern. If they do they may initiate a land-grant movement of the 20th century as significant as that which revolutionized American higher education in the second half of the 19th.

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

The Technical Institute Comes of Age

By EDWARD E. BOOHER

Vice President, McGraw-Hill Book Company, Inc.

Introduction

Surely and not too slowly the technical institute seems to be coming of age here in the United States. Its development and its recognition as an important part of the over-all technical education program of the country have been fairly rapid during the past decade. Today, I hope I can give you some idea of the present status of technical institute education here in America and its evolution as we have watched it for the past 10 years through the publication of *Technical Education News*. As many of you know, *TEN* provides a fair vantage point, for it serves as a medium for exchange of information, ideas, and opinions in this field—a sort of quasi-official sounding board.

Although technical institutes have been turning out graduates continuously for over 100 years, I feel that it is reasonable to state that the so-called modern era of technical-institute education, or at least recognition of this type of education, began just 20 years ago with the publication of the Spahr-Wickenden report. This classic study brought together for the engineering profession for the first time all the pertinent information needed to appraise the status of, and need for, the type of work then being offered by institutions such as Wentworth Institute, Franklin Technical Institute, Rochester Institute of Technology, The Ohio Mechanics Institute and a few others. Also, this report produced almost indisputable evidence that industry needed approximately 3 trained technicians or semi-professionals for every employed engineer. Yet, at the time of Mr. Spahr's survey approximately 9000 engineers were being graduated annually (by approximately 150 colleges and universities), whereas interpolation of the data in his report shows that roughly 1800 technicians were being graduated from day and evening courses in technical institutes. In other words, the actual ratio of graduates at that time, 5 engineers to 1 technician, was far removed from the desired ratio of 1 to 3. Now, some 20 years later, we find that this ratio, though greatly improved from the standpoint of Mr. Spahr's recommendations, is still in inverse proportion of 3 engineering graduates to 1 technician graduate. (Approximately 50,000 engineers in 1950 to 15,000 technical institute graduates.)

At the time of its release, the Spahr-Wickenden report created considerable discussion among engineering educators, but little happened, for these were the depression days of the 30's. For the next 15 years the technical institute type of education continued to be confined to a few well-established, endowed institutes and to the few proprietary schools that were practical enough to recognize the need for trained technicians. Supplementing these schools during the 30's was a growing number of junior colleges that offered technical-terminal programs as well as lower division general college courses.

Although there was some stirring in the technical institute field as early as 1940, it was not until we were well into World War II that the crucial need for trained technicians was thrown into sharp relief.

And as we all know, the real genesis of the renaissance in technical institute education was largely in the ESMWT courses that blanketed our educational institutions throughout the war period. The phenomenal growth of these courses and their successful operation did much to highlight the great need for a continuing source of trained technicians.

Developments

I'd like to recount some of the events and developments that point up the fact that this need is being recognized and partially met, that the status of the technical institute today is dynamic in comparison with its somewhat somnolent past.

ECPD

First on my list of events that mark the "coming of age" of the technical institute is accreditation of technical institute curricula by the Engineers Council for Professional Development.

Although the Spahr-Wickenden report had recommended the establishment of an accrediting agency, no action was taken by anyone until a group of technical institutes petitioned the ECPD for help in 1940. From that date forward, there was continuous progress.

ECPD appointed a Sub-Committee on Technical Institutes in 1944. On February 1, 1945, under Dean H. P. Hammond's chairmanship, this sub-committee announced that it was ready to accept applications from technical institutes for accreditation of their curricula under a set of standards and procedures with which all of you are familiar. Like most jobs undertaken by the ECPD, this was a difficult one, and as most technical institute administrators know, the performance of the committee was thorough. To date some 51 curricula of 20 schools have been accredited.

Dean Hammond received the first James H. McGraw Award in Technical Institute Education for his successful leadership as the first chairman of this ECPD subcommittee. As all of us who watched this development know, this award was small recognition for his untiring interest and for the stature he was able to lend this development. I'm sure that most technical institute people feel that the technical institute field will always be in his debt.

ASEE

The second important development in the technical institute field and one evolving concurrently with ECPD accreditation was the recognition by the Society for Promotion of Engineering Education of the technical institute as an integral part of engineering education.

This milestone was passed in 1941 when the SPEE created a Technical Institute Division. I might add parenthetically that McGraw-Hill's inspiration to start TEN came from the first meeting of this new division held in June, 1941, at Ann Arbor. Volume I, Number I, of *TEN*, published in September, 1941, carried a report on that meeting by the late John T. Faig, its chairman.

Although the division survived the next 5 years, it had a lean time, as, also, did most technical institutes. During some of those years there was no formal technical institute program at the annual SPEE meeting. The Technical Institute sessions, such as they were, often were held informally around the dinner tables or in the rooms of hotels that served as SPEE headquarters, with the late Walter Hughes of Franklin Tech., Ken Holderman of Penn State, and a few other zealots always planning for the future.

Well, the future arrived in 1947, when at the 55th annual SPEE meeting in Minneapolis there was a planned, announced technical institute program attended by all of 38 interested educators.

From then forward, the Technical Institute Division of the American Society of Engineering Education has had a very steady growth. Its program at the annual meeting in East Lansing last June reached a new high in meaning and interest and certainly in attendance, with 126 people attending one or more of the technical institute sessions.

NCTS

Next on my list of relatively recent developments in the technical institute field —and one we tend to overlook because we don't hear much about it—is the growth of the National Council of Technical Schools.

Some of you may remember that the National Home Study Council, which as an accrediting agency and trade association for the better correspondence schools, grew out of a study of such schools made in 1926 by the Carnegie Foundation. Certain trade and educational practices in this field at that time had been questioned by many people. The Carnegie Study and the subsequent creation of the National Home Study Council did much to purge those questionable practices. Now virtually all respectable correspondence schools operated for profit are members of that Council. Many of these correspondence schools, such as the Capitol Radio Engineering Institute and the Chicago Technical College, also offer resident courses at the technical institute level. It was this group of schools with membership in the NHSC that furnished the leadership for the formation in 1943 of a similar agency for all private, resident technical institutes—the National Council of Technical Schools. This Council is a trade association of some 20 private schools, most of which are proprietary, although two or three endowed schools hold associate memberships. Concerned with educational and business standards and practices, the Council, through its widely distributed literature, promotes its member schools, as well as the technical institute type of education in general, to secondary school students. It in no way conflicts with the ECPD. In fact, the Council has urged its membership to apply for ECPD accreditation, and to date 11 member schools have one or more accredited curricula.

Directory of Higher Education

Another mark of recognition for technical institutes and fourth on my list is the listing of about 40 such schools in the higher education section of the Education Directory of the United States Office of Education for 1949–50. This list would be considerably more extensive if some of the universities included therein listed separately the technical institute programs conducted by them.

Literature

Point number 5 that I should like to make revolves about the evidence of a growing maturity in technical institute education as reflected by the developing literature of this field.

At the moment, there is in process a compilation of a bibliography of technical institute literature by an ASEE committee on technical institute studies. A preliminary report of this committee reveals some 300 entries consisting of articles, graduate theses, and books. The great majority of entries have been produced during the past 10 years.

Also, there is an important, growing literature in the form of surveys made by the federal government, by state agencies, and by various committees of the Technical Institute Division of the ASEE. Most of you are familiar, I am sure, with two important studies made by committees appointed by the U. S. Office of Education. The first, released as *Vocational-Technical Training for Industrial Occupations,* appeared in 1944, and the second, entitled *Vocational Education of College Grade,* came out shortly thereafter.

New York State conducted what is probably one of the best surveys ever made in the technical institute field. This study was preliminary to the establishment of five new institutes of applied arts and sciences and to the creation of a unified state program of technical institute education embracing these new institutes as well as the old technical and agricultural institutes. This survey, conducted by Dr. Kenneth Beach, included a rather intensive and comprehensive study of the need for technicians in the industries of New York State. Not only did the

survey enable the state to localize intelligently the need for technicians on a geographic and population basis, but it revealed the surprising need in these areas for 7 technicians to each engineer. Entitled *Technical Occupations in the State of New York with Implications for State Institutes of Industrial Arts and Science,* the survey was never distributed generally, although I'm sure copies are available on a loan basis from the New York State Department of Education.

Those who have attended the Technical Institute sessions of the two most recent annual ASEE meetings are also aware of the important studies being carried on by certain standing committees of the Technical Institute Division. The committees on Student Selection and Guidance, on Curriculum Development, and on Teacher-Training are doing research in areas that should result in the addition of important, useful literature.

While on the topic of literature, I should mention the growing number of doctoral studies in or touching upon this field that have come to our attention during the past five years. Also, last but not least—to my way of thinking, of course—I should mention the growing textbook literature. While still inadequate, it is ample evidence that teaching materials for the technical institute are being steadily developed. At least three publishers have established publishing departments catering to this field during the past 10 years.

Completion Credentials

Turning now to another development, number 6 on this seemingly endless list, I should like to bring you up to date on the matter of completion credentials.

One of the conclusions reached in the Spahr-Wickenden report was that technical institutes had been handicapped by the fact that their graduates received no educational credentials which were generally recognized. Yet, for a number of reasons, no recommendation was made other than to state—"The matter must remain inconclusive until the representatives of the technical institutes are themselves prepared to take the initiative." It seems that the technical institutes are now about prepared to take such initiative.

For the past two years, the Technical Institute Division of the ASEE has had a working committee on completion credentials. In East Lansing last June, the chairman of that committee, R. Warren Marsh of Buffalo Institute of Applied Arts and Sciences, reported preliminary findings of his committee as follows:

1. Over 300 firms employing in excess of 7000 technical institute graduates reported by questionnaire the titles or terms used to designate a technical institute graduate.
2. A total of 149 or slightly less than one-half of the entire returns indicated the title of technician or some modification as being used at the present time.
3. 77 or about 25% of the total indicated some form of engineering or associate.
4. Others indicated a wide range of titles, many of which were simply job titles such as draftsman, estimator, etc.

Mr. Marsh's committee is continuing its work this year and possibly at the next annual meeting will be ready to make some final recommendation.

In the meantime, however, a few institutes, notably those of New York State, have adopted the accepted junior college degrees of Associate in Arts or Associate in Science.

Growth

Finally on my list of items which bespeak the position of technical institute education today is the actual growth in the number of institutes, and even more important, the growth in technical institute enrollments.

Perhaps our most reliable data on this growth is that found in the annual survey of technical institutes prepared by Leo Smith, Chairman of the Educational Research Office of Rochester Institute of

Technology. These surveys, incidentally, have appeared in the June issues of *TEN* for the past seven years. Let's look at his figures: For the school year 1945–46 * the survey showed a total of 69 institutes. In 1950–51 Smith lists 66 institutes. His data tend to be misleading in that they indicate a decline in the number of institutes. Actually this is not so, since two universities that have established several technical institutes during the past six years are listed as single institutions. Making the proper adjustments, we find that the total number of technical institutes has grown from 69 in 1945–46 to 80 in 1950–51. Referring to this same period, we find an even more impressive growth in enrollments. Total enrollments, day and evening, were 18,656 for the year 1945–46, while by 1950–51 Smith shows they had climbed to 46,441. This increase of 150% in technical institute enrollments for a 6-year period compares most favorably with an increase of 135% in engineering enrollments which for the same period went from 69,146 to 161,592. And, of course, these figures represent a healthy rate of growth since 1928, when the Spahr-Wiekenden figures of 4115 enrolled in 10 technical institutes represented approximately one-half the total enrollment at that time.

In addition, there are recent developments too new to be included in Smith's figures that also reflect a continued growth. For example: (1) New Hampshire has recently converted two former trade schools to state technical institutes with programs on the post-high-school level. (2) The Marine Corps Institute has recently revamped part of its program to offer courses that meet technical institute standards as defined by the ECPD. (3) The Louisiana State Department of Vocational Education has recently completed a survey recommending the establishment of several two-year technical institute curricula and requiring 3 new institutes on the post-high-school level. Incidentally, this survey, like that done for New York State, is an interesting piece of work, for it attempts to establish 3 rather basic sets of data—first, technical occupations for which curricula should be provided, second, the number of students for whom provision should be made, and third, the geographic areas of the state in which these curricula should be offered. Another interesting point covered in this survey is the ratio of technicians to professional engineers, which varied from 3.6 to 1 in crude petroleum production to 31.6 to 1 in contract construction. Copies of this 51-page report are available from the State Department of Commerce and Industry, Baton Rouge, Louisiana.

All of this speaks well for the technical institute as we examine it today in light of its growth and recognition over the past 20 years. I know that Mr. Spahr, when he received the technical institute award in East Lansing last June, felt that the strides made in this field during the past 10 years have far outstripped his most optimistic estimates.

The Future

But with this perspective of the past 20 years to guide us, wouldn't it be well to appraise the future of the technical institute in the next 20—to prognosticate a bit?

Frankly, I'm not sure that the outlook for the future is as good as the trends of the immediate past would indicate. In making this statement, I have in mind the technical institute as we have known it, a distinctly individualistic institution rendering an industrial service as an important part of the whole of engineering education. My reasons for so feeling are two, and neither centers around anything so tangible or concrete as UMT, for example. Problems of this type usually can be met and assimilated. Nor can my reasons be founded on the prospects of a diminishing need for technicians or diminishing enrollments. Enrollments in

* The data of Smith's first survey covering the school year 1944–45 is somewhat incomplete. Therefore, for the purposes of this paper we are omitting that first year and using only the data from the last six years, 1945–46 through 1950–51.

higher education are forecast to reach 3,000,000 by 1960 compared with 2,225,000 today, although they may continue to decline slightly up to 1956, when the population curve representing individuals of college age reverses the downward trend found today. Actually the prospects for technical institute enrollments in the next 10 years are very healthy. Probably the need for industrial technicians will be greater than ever before.

My first reservation about the future growth of the technical institute is conditioned by the seemingly certain growth of the junior college, or community college, as it might more accurately be termed.

The community college is a potent, dynamic force in American education. Its strong, aggressive leadership is casting covetous eyes on the field of technical-terminal education, so much so, I feel, that this type of institution may in the future assume the function of the technical institute as we have known it. Here are some figures to make us sit up and take notice. You will recall that Smith's surveys show a total increase of 11 new technical institutes in the past 6 years. But the Directory of Higher Education for 1950 states that 89 new institutions of higher learning were established in the United States in 1949 alone, and that more than one-half of these are junior, or community, colleges! Further, Earl J. McGrath, U. S. Commissioner of Education, predicted last year that by 1960 an additional 500 community colleges will have opened their doors. It is my guess that a majority of these new community colleges will include in their offerings courses of the technical institute type, and in many instances full technical institute programs.

Why does the junior, or community, college seem to be such a threat to the technical institute we have known? What evidence of its movement toward the field is there?

First, as a strong social force, its 1950–51 enrollments stood at 562,786 in 634 institutions according to the 1951 Junior College Directory. In other words, there are 8 times as many junior colleges as technical institutes, with enrollments over 10 times as great.

Second, the junior, or community, college through its American Association of Junior Colleges presents a united front, strong in local, state, and national political influence, strong in promotion of its basic educational concepts, and strong in developing new ideas and ideals for this area of education.

Third, the community college is neither the appurtenance of the four-year college or university, nor is it controlled by the secondary education group, although in many localities it is an extension of the latter. But it stands independently, kowtowing to no other educational group.

Fourth, since one of its basic precepts is to service the educational needs of a community, it usually succeeds in enlisting the support of all facets of a community and in growing numbers secures its financial support from public funds or taxes. This, in turn, means that most newly established community colleges are virtually tuition free.

Fifth, it purports to operate more economically because it can shelter under one roof, so to speak, a variety of activities, no one of which might be operated alone with such economy. For example, it can house in a single plant a senior college preparatory course, a technical institute, a business institute, and a flexible, ever-changing evening program in so-called adult education. The argument for this sort of local educational set-up is a strong one, as many of you know from first-hand experience. Further, I'm sure that Mr. Spahr did not foresee all the implications of this developing junior college movement back in 1930 when he wrote, and I quote from his summary report:

"There is no basis in experience for expecting the junior college of a mixed character to do the work of a technical institute successfully. The junior college is in reality an extension of secondary education and its curriculum a truncated college course. Public authorities are gradually bringing the junior colleges under regulations governing

the qualifications and status of teachers similar to those which apply to high schools. The junior college of the prevailing type seeks to blend the educational theories of the mixed high school with scholastic work of a purely college type. Terminal courses of an intensive and rigorous character may in time be developed, but it is hard to see how they can fulfill the purposes contemplated in this study in an essentially secondary environment. The technical institute needs a director and staff who are in intimate touch with industry and specially proficient in blending scientific and practical instruction rather than leadership of the 'educationist' type.''

Although the position of the junior college in the field may in time develop into a serious issue, it is not the only stumbling block to continued growth of the traditional technical institute. Another problem, and one I feel to be of considerable importance, is the uncertain relationship of the technical institute to the engineering college.

The relationship of the technician to the engineer has been pretty well established as being one of mutual benefit and respect. Yet, I wonder if this same relationship exists between the technical institute and the engineering college, between the technical institute instructor and the engineering professor. This statement may seem out of place in view of the evidence just presented, especially the parts played by ECPD and the ASEE in fostering technical institute education. Yet, it seems to me that there is evidence that the technical institute has always been a stepchild, never a child; that the engineering colleges tend to provide "protective custody" but not guidance and affection; and that the engineering colleges tend to appraise results by their own academic standards, which no technical institute can meet, except as it follows the footsteps of several former technical institutes and becomes an engineering college.

Still engineering educators have a big stake in the training of qualified technicians. Thus, it would seem that if for no reasons other than selfish ones, they should face up to the problems ahead. The inadequacy and unsoundness of this relationship was recognized in the Spahr-Wickenden report, and I'm sure it is recognized today, by both engineering and technical institute educators. It is the feeling of some that this attitude of professional superiority on the part of engineering educators and of professional inferiority and inadequacy on the part of technical institute educators will be dispelled only if and when the technical institute becomes strong enough to establish a professional organization of its own. But if that day is to come, then the technical institute will need from engineering education all the respect, guidance, and filial guardianship that it can absorb, so that it might have the courage and pride to push ahead toward a goal now in sight but still encumbered by a number of problems. If I may say so, it seems that the challenge of training technicians for the years ahead is as much in the laps of the engineering educators as it is in the hands of the technical institute instructors.

Examinations for the Selection of Engineers*

By A. PEMBERTON JOHNSON

Project Director, Measurement and Guidance Project in Engineering Education, Educational Testing Service, Princeton, New Jersey

Gentlemen, it is a real privilege to talk with you about *examinations for the selection of engineers.*

In spite of the growing critical shortage of engineers, it is my belief that selection (and guidance) examinations can help materially at several educational levels to combat that shortage. My work during the last two years as Project Director of the Measurement and Guidance Project in Engineering Education, during the 3 years preceding that as Coordinator of Personnel Guidance at Purdue University and my association with engineering education since 1928 as student, graduate student, teacher, and personnel counselor suggests to me that the needs for and uses of tests at the different levels is quite different.

It is my belief that, as a group, you are primarily interested in examinations useful for engineering college freshmen. I would like first to report to you the findings of a survey undertaken last spring and tabulated too late to have been reported at the Seattle meetings of the Society. Some of you may have seen these findings in the form of a memorandum distributed last January to Deans of Engineering, Directors of Admission, and Student Counselors at Engineering Colleges through the channels of the Engineering College Administrative Council.

On April 19, 1950, Dean Ovid W. Eshbach, then Chairman of the ASEE Committee on Selection and Guidance, wrote to a number of engineering colleges requesting the names of tests used for admission and counseling freshmen engineering students. Replies from 113 colleges of engineering were received and analyzed. Through the courtesy of the Committee on Selection and Guidance and of Dean Eshbach, I am privileged to present these findings.

Certain tests are in widespread use in colleges of engineering throughout the country. More than 41% of the colleges which replied were using the American Council on Education's Psychological Examination, 39% were using the Cooperative English Test. Next most widely used tests were the Pre-Engineering Inventory and the College Entrance Examination Board Tests. Educational Testing Service is pleased that it is able to serve engineering education through these four examinations.

Frequent use of Interest tests and of Mathematics tests of a wide variety was also found.

Most Widely Used Tests Described

A brief description of the four most widely used tests follows:

(1) The ACE Psychological Examination for College Freshmen—This test is an indicator of general scholastic promise. It is slightly more predictive of success in Liberal Arts curricula than in Engineering curricula.

(2) Cooperative English Test—Higher Level—This is a carefully de-

* Presented at the Educational Methods Conference of the ASEE at its Annual Meeting in East Lansing, Michigan, June 25, 1951.

veloped and extremely popular test for measuring reading comprehension and knowledge of good English usage.

(3) Pre-Engineering Inventory—This test was developed specifically for use as an engineering freshmen selection and guidance aid and has proved very effective for these purposes. It was available prior to December 31, 1950 on a rental basis. Since January 1, 1951, the Pre-Engineering Inventory has been available on a sale basis primarily for local scoring but with ETS scoring and reporting still possible.

(4) College Entrance Examination Board (CEEB) Test—The Aptitude and Achievement examinations of the College Entrance Examination Board are administered by Educational Testing Service at 500 centers located throughout the world. These tests, highly predictive of grades in college, are the most widely used college entrance selection tests in existence. Like other entrance examinations, their greatest predictive effectiveness is realized when scores on the tests are combined with secondary school grades. This can perhaps best be shown graphically as in the chart I shall now distribute to you. (Distribute and explain the chart entitled Excellent Prediction of Scholastic Success in a Group of Five Engineering Colleges by the College Board Test Scores Combined with High School Grades.)

The Strong Vocational Interest Blank and the Kuder Preference Record (Vocational) were at 5th and 6th place in this survey of tests used in the engineering colleges for selection and guidance purposes. Seventh place was held by the Cooperative Mathematics Tests including the Intermediate Algebra, General Achievement Test, Mathematics Pretest for College Students, and the Trigonometry Test. I shall be glad to give anyone information regarding any of these tests including references to the literature.

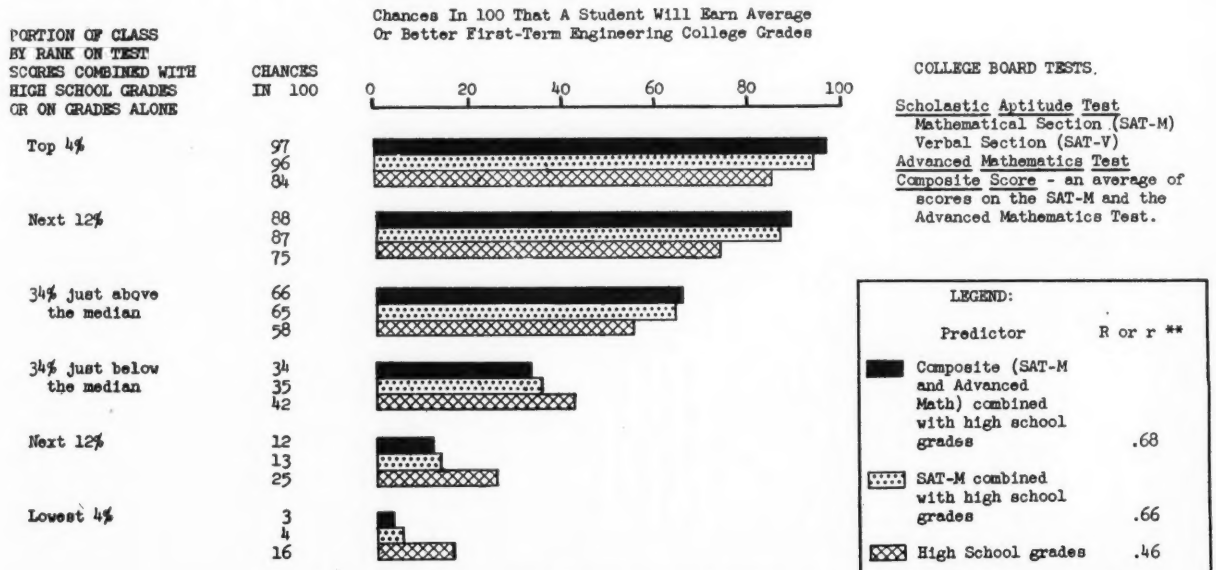
Pre-Engineering Inventory

A number of users of the Pre-Engineering Inventory are well aware of the excellent predication of first term engineering college grades which this test has consistently given. The best prediction is typically made by the composite score.

As would reasonably have been expected with the marked decline in numbers of freshmen engineering applicants, use of the Pre-Engineering Inventory has declined greatly in the last few years. One engineering educator has estimated that there may be regular facilities for as many as 55,000 freshmen in our engineering colleges while enrollments in September 1950 were only about 34,000. It became evident, therefore, that it was no longer feasible to continue indefinitely distribution of the Pre-Engineering Inventory under the rental plans. After due consideration of the matter and in order to continue to make the Pre-Engineering Inventory available to meet the needs of the engineering colleges, the joint ASEE–ECPD Advisory Council on October 22, 1950 approved the sale rather than the rental of both the short (4-hour) and the long (6-hour) forms of the Pre-Engineering Inventory beginning January 1, 1951.

At the same time, approval was given to the plan for development from the two most predictive parts of the original inventory (Comprehension of Scientific Materials and General Mathematical Ability) of a new 80-minute Pre-Engineering Ability Test which becomes available on July 1, 1951. This test is designed to meet the need for a short, inexpensive, and easily administered test which is generally quite predictive of scholastic success in engineering colleges, very nearly as predictive as composite scores on the Pre-Engineering Inventory. Norms carefully equated to the original national norms for the Pre-Engineering Inventory will be furnished so that the test can be effectively

Excellent prediction of scholastic success in a group of five engineering colleges by college board test scores combined with high school grades*



(Bars are shown at theoretical lengths - actual lengths at individual schools might differ slightly).

*Data, courtesy of Dr. W. B. Schrader, for 721 enrolled engineering freshmen tested during their first week in the Fall of 1948 at Carnegie Institute of Technology, Cornell University, Lehigh University, Rutgers University, and the University of Pennsylvania.

EDUCATIONAL TESTING SERVICE
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used as soon as it is purchased. In addition, a long table of American Council on Education Psychological Examination and College Entrance Examination Board test scores comparable to Pre-Engineering Ability Test scores is furnished together with intercorrelations, means, and standard deviations for the group of freshmen at one school on which these data are based. The new 80-minute test is easily administered with separate time limits on each of the 2 parts and easily scored by counting the total number of correct responses to both parts.

Proper Use of Examinations Can Help Reduce Growing Shortage of Engineers

Because, I believe, that the proper use of examinations as far back as the 7th grade can materially help in reducing the growing shortage of engineers, I would like to speak briefly about some new developments in that area.

Last December, Professor Paul Cambreleng of Newark College of Engineering, President of the New Jersey Guidance and Personnel Association, conducted a survey among public secondary school counselors in New Jersey regarding the grade level at which consideration was given to counseling regarding the selection of college curricula. One hundred returns from over 50% of New Jersey public senior high schools and from a few private school counselors indicated that counseling regarding the selection of college curricula commonly began in the 8th and 9th grade. I have been told by some secondary school people, that it occasionally begins in the 7th grade. When we studied the matter a bit we realized that it is at the 7, 8, and 9th grade level that the prospective engineering student must begin his mathematics, science, and English sequences of courses to be ready to meet the entrance requirements of many of our engineering colleges. It is my belief that more study should be given to examining students in the 7th, 8th, and 9th grades looking to the early identification of those with the apparent interest and aptitude to prepare for and complete an engineering college curriculum. The Cooperative Mathematics Test and the Cooperative Science Test for grades 7, 8, and 9 have been found to be suitable for use with superior groups in these grades and some entire classes in the next one or two higher grades. The Cooperative General Achievement Tests, Tests of General Proficiency in the Fields of Mathematics and Natural Sciences are useful in the 10th to 12th grade range. The Cooperative English, Single Booklet Edition, Lower Level, or the separate tests of Mechanics of Expression, Effectiveness of Expression, and Reading Comprehension are useful for the 7th to the 12th grades. Other tests frequently mentioned in the New Jersey survey were the Kuder Preference Record (Vocational), the Otis Tests of Mental Ability (all forms), and the Differential Aptitude Tests. Some of the larger city school systems and certain of the state systems have developed their own programs which could be used effectively to discover potential engineering students.

For those secondary schools enrolling both English-speaking and Spanish-speaking students, the Cooperative Inter-American Tests of General Ability, Reading, Social Studies, Natural Sciences, and Language Usage with their parallel English and Spanish editions, should prove especially useful.

Selective Service College Qualification Tests

At all college levels, Selective Service College Qualification Test scores will soon be used by local selective service boards in addition to or as a substitute for rank in college class as a basis for the deferment from immediate military service of enrolled college students. We have already tested nearly 300,000 persons for the Selective Service System in this connection and other tests are to be given on June 30th and July 12th. It is our belief on the basis of rather inexact information, which was the best we could get, that an appreciable number of engineering stu-

*Data, courtesy of Dr. W. B. Schrader, for 721 enrolled engineering freshmen tested during their first week in the Fall of 1948 at Carnegie Institute of Technology, Cornell University, Lehigh University, Rutgers University, and the University of Pennsylvania.

dents will be eligible in most engineering colleges for deferment on the basis of their Selective Service College Qualification Test scores.

At the sophomore level certain institutions have found the new College Transfer Test of the College Entrance Examination Board, a 3-hour morning Aptitude test, which yields a verbal and a quantitative score, to be quite useful in evaluating the ability level (exclusive of scholastic achievement) of prospective transfer students. These institutions commonly make use of the freshmen-sophomore grade record, together with a careful scrutiny of courses taken, as the best measure of scholastic achievement. Other institutions have found the Engineering Achievement Tests to be very useful indicators of achievement to date of prospective transfer applicants. A considerable potential of at least moderately well-trained transfer applicants is believed to exist in many areas.

At the college senior-prospective graduate student level, Educational Testing Service will introduce a new 3-hour engineering examination in the fall for the National Program for Graduate School Selection of the Graduate Record Examinations. This examination has a first section of 100 questions considered common to the major branches of engineering and a second section of 100 more difficult questions, 25 each in the areas of Civil Engineering, Chemical Engineering, Electrical Engineering, and Mechanical Engineering, so that the student may choose not only those 25 in any particular area in which he feels best qualified but others as well. The new aptitude tests, the profile tests, and the Advanced Tests of the Graduate Record Examinations in Chemistry, Mathematics, Physics, and 14 subject areas other than engineering, are worthy of mention.

It is my belief that, with growing knowledge of the availability of testing programs at these different levels and with recognition of the role which examinations can play in encouraging qualified persons to enter upon an engineering career, the examinations I have mentioned will increasingly prove their value to engineering educators.

In the News

Young Engineer Training Program Imminent

An organized program to aid young engineers in the first five years of professional development through the medium of a network of local committees made up of established practicing engineers is being sponsored by the **Training Committee of Engineers' Council for Professional Development.** Under the chairmanship of A. C. Monteith, Vice President in charge of Engineering and Research, Westinghouse Electric Corp., Pittsburgh, Pa., the Training Committee presented a 6-point program to aid the young engineer in the right type of training, of indoctrination, and of self-analysis.

The program presented examples of orientation and in-service training, continued college education, introduction to community service, indoctrination in characteristics, responsibilities and ethics of the profession leading to recognition through registration, self-appraisal for the purpose of orientating personal plans and of selected reading for professional and personal growth.

To implement the program the committee proposed that an extension director be employed for the purpose of organizing the resources and agencies which might help in establishing programs in a number of chosen communities. Funds are presently being raised to initiate the program.

Engineering Design as Related to Research*

By Forest McFarland

Chief Engineer, Design and Research Division, Packard Motor Car Company

In considering the subjects covered by the title, the first questions which might well be asked are, "What is Design?", and, "What is Research?". Webster states that design is "the production of a scheme or plan for the making of anything." This is certainly a definition in its briefest form. He also states that research is "careful or critical inquiry or examination in seeking facts or principles." This is likewise brief and broad.

Many definitions have been offered to explain the meaning of research. None is entirely adequate. From the standpoint of final result, the statement that "research has been called insurance against capital loss" is significant. Rather than attempt to define design or research further, a few examples will be given to illustrate these two functions of engineering and their relationship.

What can we classify as design in a broad sense? What is its history? When did designing start?

Excavation by Sir Arthur Evans on the Island of Crete revealed the remains of the Neolithic or Later Stone Age culture which reached back 13,000 or 14,000 years. Man's real design and construction effort, however, could not begin until he ceased to wander in search of a precarious livelihood.

What examples do we find of early design? According to M. C. Burkett, Lecturer of Archaeology and Anthropology at Cambridge University, the oldest known wheeled vehicle was discovered at Kisch, the world's oldest city, and was built about 3200 B.C.

Much has been written about the structures erected by the Egyptians, Greeks, and Romans throughout the centuries following, the last two periods being marvelous eras of unsurpassed architectural design.

After the fall of Rome, architectural design of a grand order disappeared in Europe and western Asia until the Middle Ages when the building of cathedrals and monasteries again revived it. Design of a more mechanical nature began to appear. Time keepers are one interesting and common example of design of this type. Starting with the sun dial, apparently used as early as 2000 B.C. in the valleys of the Tigris and Euphrates, we next come upon the Clepsydra or Greek water clock invented by Ctesibius at Alexandria in the second century B.C. Sand took the place of water in many clocks, one variation being the 28-second sand glass used for a long time for determining the number of knots or nautical miles per hour covered by a vessel. The origin of the first design of mechanical clock is somewhat in doubt, but in 1360 there was evidence of at least one mechanical clock designed by Henry Weeck, or Henry DeVick as afterward called, of Wurtemburg, for Charles V of France. Clock and watch designs appeared in many forms finally developing into those which we have today. Space prevents mentioning many more examples of design, such as the works of Leonardo de

* Presented at ASEE Summer School for Engineering Drawing Teachers at East Lansing, Michigan, June 26, 1951.

Vinci, Cellini, and other marvelous craftsmen with whom we are all familiar.

History of Research

What was occurring in research, taking it in its broadest sense, over this period of time?

In Egypt the practice of preserving the bodies of the dead by mummification has excited the wonder of mankind for ages. G. Elliott, Professor of Anatomy, University of London, states this practice extended over at least thirty-five centuries and that it underwent an unbroken series of different techniques. That I would call a "long term" research project.

One example of a very complete report on early investigations came to my attention a number of years ago in a curious way. In the mathematical analysis of a problem, I came across a proposition in plane geometry with which I was unacquainted. This aroused my curiosity. As I needed a new geometry reference book, I journeyed to the Detroit Public Library and surveyed all the works available and found one by Sir Thomas Heath, in three volumes, which was very complete—a new translation taking into account all of the information unearthed since previous translations had been made. I found the proposition that had been new to me, and discovered that the geometry taught me in high school was from a very much abridged edition of the complete works compiled by Euclid in thirteen books to cover the information available 300 years B.C.

De Morgan, the British mathematician, stated in 1848, "There never has been, and till we see it we never shall believe that there can be, a system of geometry worthy of the name, which has any material departures (we do not speak of corrections or extensions or developments) from the plan laid down by Euclid." Heath states that had De Morgan lived at that time (1925) he would still be of the same mind. The fact that this work has lived for twenty-two centuries without any revisions or significant additions marks it as being an investigation and summary of the highest order. The elegance of the propositions in their simplicity and choice of language commands further respect and should cause all of us to reappraise some of our contributions in the light of that from which we have had to draw.

The history of design in clocks was mentioned. Prof. W. I. Milham, in his book, "Time and Timekeepers," states that since 1368 when the pendulum was introduced into the clock mechanism, there have probably been nearly three hundred different designs of escapements experimented upon and nearly one hundred escapement designs for watches. So we realize the designs of our modern mechanical clocks and watches are the result of an enormous amount of investigations and tests.

We could list many investigations made over the centuries labeled as discoveries, developments, and so on, from the wealth of material available. Two or three examples were touched upon to stress the point that design and research are by no means items peculiar to the last half century or so.

Relationship of Contemporary Design to Research

In considering the relationship of contemporary design to research, there are two broad phases which are diametrically opposed which immediately come to mind. The first is where designs are partially developed and to be completed must wait for research work to permit their completion. The second phase is where "long term" research develops products which are eagerly seized upon by designers after they are introduced and often used in many forms never anticipated by those who developed the product.

Let us consider the first phase, particularly in the automotive field and aircraft engine field in which the writer is best acquainted.

For many years we have all been trying to make automatic transmissions for cars that would do a better job than the hard

shift mechanism. In the minds of some of us for a long time and over the last ten years in particular, the idea has been present that a better design could be evolved if the torque converter invented by Fottinger in 1906 could be made acceptable for passenger car use. This has resulted in our designs being held up, so to speak, until sufficient research work was done to give assurance that this element could be included in the design. This work has resulted in four distinct and different combinations being in production today. We have them because the research work on the product indicated four answers, all of them acceptable commercially.

Another example of design waiting for research is in stress determination. During the last war, test experience disclosed a weakness in an existing design of blade connecting rods in an aircraft engine manufactured by the company with which the writer is associated. A Stresscoat, or brittle lacquer investigation, showed a highly stressed point which was greatly reduced by removing metal from the existing design. Test results confirmed the findings and approximately one-quarter million dollars worth of blade rods were saved by reworking the existing rods. This is clearly a case of design "waiting" for research.

Another example which the writer has cited is in regard to surface finish on the cam followers of the same engine on which a smooth honed finish was discontinued, using the ground finish only, present before the honing. This procedure eliminated approximately ninety per cent of the scuffing of the followers, present with the original finish. Another case of design waiting for research for improvement. This particular item points out one highly significant fact in engineering design—that the parts themselves will tell you what operating conditions they like or what is "good" or not, which may well be at variance with certain theories not based on facts. This leads to the moral that one must have an open mind at all times until competent testing reveals the facts.

Another example of design waiting for research was in the development of the transmission brought out by the writer's company two years ago.

The direct clutch and torque converter assembly had a combination of members, all of which were Stresscoated with brittle lacquer and spun at a series of increasing speeds to determine the highly stressed points. A considerable number of design changes were made to reduce these stress raisers and a final check was made by bursting all of the parts involved.

Many more examples could be given to show that design must wait for investigation or research before it can proceed safely. This is one of the biggest unknowns in attempting to "time" the commercial introduction of basically new designs.

Research Covers a Broad Field

I may be challenged by some for including some of these examples as research. My only answer is that present research covers a very broad field. We have all heard much about the new nuclear research. Most of us, however, have not heard of and do not realize the vast amount of manufacturing research that is going on. One other example is the work of Dr. Hans Ernst with the Cincinnati Milling Machine Co., on the actual behavior of the metal in the cutting process. His exceptionally clear high-speed movies show that ordinary chip removal is definitely a shearing process at a well established angle instead of being a "paring" process as pictured in many illustrations for years. This is a definite contribution to our knowledge of a process used for centuries.

Let us take the other side of this picture where designers use the products of research. This can probably be illustrated best by a number of examples.

In the early Thirties, the writer had occasion to work on the development of the first rubber crankshaft vibration

damper used by our company on passenger car engines. Our tests had shown that there must be a combination of an elastic coupling and friction present between the damper flywheel and the crankshaft. Our tests also showed that rubber had no friction present of commercial value. This resulted in our employing friction discs in addition to the rubber elastic coupling. If we were to design this damper today, we would have available rubber "loaded" with certain compounds that would add friction to it or give a "hysteresis loop" of sizable value so we would doubtless eliminate the friction plates. However, research has also brought another party into this picture—silicone fluids of constant high viscosity which are now used in dampers, eliminating the mechanical friction materials and rubber, also. In our early work we had visualized how nice it would be to mount a flywheel in a casing only but knew the oils we were acquainted with would change too much in viscosity to be commercial.

The development of plastics has made designs possible that could not be considered a few years ago. Gears can now be molded from nylon at a fraction of the cost of cutting them. For many purposes the nylon gears are superior to the metal gears. This is only one of many uses plastics are being put to.

The DuPont Company has just completed an experimental station for fundamental research, built over the last three years at a cost of 30 million dollars. DuPont defines scientific research as "a critical investigation in the physical sciences directed to discovery of new knowledge." The company divides research into three categories: Improvement in existing processes and products; development of new ones; and fundamental research to uncover new knowledge without regard to specific commercial objectives. DuPont says it does research because it has to. This can be well understood when we realize that more than half of the company's sales in 1950 were in products either unknown or in their commercial infancy twenty years ago.

In thinking about the relationship between design and research, one thing always comes to my mind—that is the importance of proper analysis of the design in the light of what it is to accomplish. I have seen a goodly number of designs that were not operable which could have been "saved" or made to operate by being properly analyzed and the indicated steps taken to correct the design. There is no function in engineering design or development that pays off so well for the effort expended.

Importance of Fundamentals

To properly and efficiently analyze designs, the young engineer should know his fundamentals well, not just have a speaking acquaintance "with" or "of" them. I found my own collegiate education lacking in elementary mathematics, kinematics, advanced mechanics, particularly in vibrations and some other courses. I feel my own collegiate education would have been more valuable had more time been spent on the fundamentals of all the sciences and less on general reading courses. After the student has finished his formal or "official" education, he has to read and glean information all his life anyway. The time spent at college can be used best in equipping him with the "best" tools possible for his future use.

What must industry have, to be willing to finance research on a long-term basis particularly to yield products that designers or others may use? Industry must be able to reap a fair reward for promoting many projects, most of which will not pay out as it is only a gleaning of the many projects that finally becomes one of the future products of the company. Over a period of time, engineers and others will thrive only as the organization they are in thrives. We each have a personal responsibility to do our bit toward keeping our economic and governmental structure on a sound basis. That permits and encourages companies to extend their

selves research-wise with reasonable rewards possible for developing new and better products.

Individual Freedom Necessary

Companies and individuals must continue to operate in an atmosphere where individual freedom continues to encourage research and design so they will continue for the benefit of the many, and will result in the satisfaction of creativeness in the individuals engaged in the work which is one of the major dividends to them.

I hope these few brief remarks and examples will serve in a small way to demonstrate how research and design work together and under what conditions they can operate most effectively.

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DEVOTED TO THE INTERESTS OF ENGINEERING DRAWING

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Mid-Winter in New York

By M. B. LAGAARD

Chairman, Engineering Drawing, Northwestern University

and

B. L. WELLMAN

Professor of Mechanical Engineering, Worcester Polytechnic Institute

The Mid-Winter Meeting of the Engineering Drawing Division, which was held in New York on January 23rd to 25th, will be long remembered by those who attended. Members of the host institutions, Columbia University, The Cooper Union, and the U. S. Military Academy are to be congratulated for their well planned program.

The Cooper Union was our host on the first day. Following a tour of their historic Foundation Building, Mr. Renato P. Iodice presented a paper on the application of descriptive geometry in shipbuilding. The content of his talk was carefully designed to lay the groundwork for our afternoon visit to the Mold Loft of the New York Naval Shipyard. There Lt. W. J. Dixon demonstrated with the aid of two loftsmen the development of a shell plate of a ship. The work was carried out in detail from the given frame lines of the ship to the actual layout on the loft floor of the full-size paper template. The tour through the ship-fitters shop showed how the massive plates are cut, beveled, drilled, and rolled to proper shape.

Columbia University entertained us on Friday. In the morning session the announced paper by Mr. Lloyd E. Varden on photographic processes was followed by two others. Professor L. R. Schruben of the University of Southern California spoke on the relations of the engineering freshman to his drawing instructor, and Professor H. B. Howe of Rensselaer Polytechnic Institute described some of the statistical research methods he has used to test his teaching procedures in drawing and descriptive geometry. After the luncheon and business meeting the afternoon was devoted to inspection trips.

No greater substantiation of the fact that drawing is a basic and fundamental part of all engineering could be found than in the curriculum at West Point, where the same organization that trains the man also employs him after he graduates. The thoroughness with which they cover the field of drawing is ample evidence of the importance they attach to it.

(*Continued on page 372*)

Improvement of Cooperation Between Industrial Engineering Faculty and Industry *

By ROBERT T. BORTH

Manager, Community Relations, Employee Relations Division, General Electric Company

I am indeed grateful for the opportunity to appear before you distinguished educators today—and for a three-fold reason: First, because I am directly concerned with industrial relations—struggling daily with its problems in the General Electric Company—and I come to you for help, and advice. Second, because so much of the future progress of the American free competitive enterprise system (our profit or loss system) depends upon our success in the area of industrial relations—on the pursuit of job satisfaction for the 60 million people of our working force, and upon their acceptance of ever greater technological advancement in arm-lengthening tools. I welcome always an opportunity to help expand the horizons of our industrial thinking. And third, because you, in the field of education, can accomplish so much in the development of sound-thinking economically-statesmanlike future leaders in our businesses and professions. We in industry welcome any opportunity to discuss our growing problems with you— problems which we must solve together.

Perplexing Problems

Believe me, I appear before you today in sincere humbleness—nothing quite so humbles all of us businessmen as failure in the midst of success. Mr. Lee of Standard Brands put it quite clearly in a talk a couple of weeks ago when he said: "The people will go into the stores and vote for your products by purchasing them, and then go to the polls and vote you out of business."

We business men, we like to think, are people of the highest ability, the best intentions, and the architects of the greatest standard of living in history—both as to material and spiritual well being. We are great physicists, chemists, engineers. We are phenomenal manufacturers. We have been fabulous financiers. We are superb in individual selling and mass marketing.

Yet, as the whole man of business—the manager and leader—we are condemned. When we try to merchandise the overall economic and social consequences of our operations, we fail. In fact, it has become the habit of many politicians to believe that the way to *sure* election is to promise, the correction of our "wicked abuses," to our employees and the public. This is a successful habit not just of cheap and ill-mannered politicians, but of those of the most impeccable backgrounds of family and education.

People like—and respect—the results of our separate professional skills. But taken as a whole, our activities seemingly are regarded by a majority of the public as anti-social.

How do we find ourselves in this situation? With our customers, stockholders, and vendors approving of us, to be sure. But with our employees and their allies—the unions, the government, too often the clergy, too much of the public—in other

* Presented before the Industrial Engineering Division at the Annual Meeting of the ASEE, Troy, N. Y., June 22, 1949.

words our real bosses—not only not respecting and liking us, or even appreciating or understanding us, but even not crediting us with good intentions—with being on their side—by which we mean being on the side of what's good for all.

People are led to believe that the jobs we provide are not what they ought to be. They are led to believe that the economic and social consequences of our activities, and the system back of our activities, are not what they ought to be for the good of each community and of the nation. They think that we are smart, skilled, technically honest, but coldly selfish and not on the side of employees and the public.

As a result, they not only do not *seek* our participation in important affairs, in the running of the country—but in many fields they don't *permit* it—and we are largely ruled out of councils as undesirables. Yet we are the same people who give largely those same people the products and prices they like in the individual cases, in the direct or indirect investment safety and return they have liked.

What can be the matter? What ought to be done? And who ought to do it? We, at General Electric, think it is largely the job of business. But you educators can be a tremendous help.

At G. E.—where we have all these questions—we decided two years ago that we, at least, would have to try to do something about it, and that we certainly must not continue to take these puzzling problems lying down—or go on about our customary pursuits being technically successful while failing in the larger and the only really important sphere of true personal accomplishment and real social usefulness.

The Approach

We determined to try to draw on our sales and general management experience to determine what were all the things which we did to make us successful in the product sales field but which we were not doing in the job customer and community relations field.

Using typical market research to learn the likes and dislikes of our employees and then employing product planning methods, we determined that our first job was to have us all in management—that includes foremen—work toward giving each employee a new model job with nine specific features the employees had said they wanted.

Our approach toward this 9-point, new-model job was along three lines.

(1) Getting and keeping the pay, working conditions, and other material characteristics of each job up to the ever-rising standards in these respects—VOLUNTARILY.

(2) Getting supervisors at all levels to establish genuine and continuous and intimate two-way communication with each employee—to respect his dignity, supply him with desired information, give him a real sense of importance and participation,—and act like salesmen instead of bosses, getting the employee to want to do what's wanted and not in any sense be driven to do so.

(3) We think we have found that even if the employee—or his family and neighbors—feel he has got the best pay, best working conditions, and best boss in town—if he feels his boss and company have been literally "born again" and are on his side, and are really putting human considerations first—it still isn't enough.

And right here we run into what I think is the most colossal and the most pressing problem of our times. We know, for instance, how to price our jobs and how to be the salesmen to sell and satisfactorily serve our job customers—and we only need to transfer to that area the skills we have developed in our product marketing departments.

But we have few skills in this third area. Few of us know, or can put convincingly in words of one syllable, the reasons why our profits are not the reason for high

prices as the left-wingers charge. Too few of us really know our economics—the relationship of wages, prices, taxes, and profits and loss—the function of savings and of investment in technological advances—the social gains of incentives and competition in a free market of millions of individual decisions versus central planning—how we can and do raise our real wages, our real standard of living—how we get into a disinflation like the present, and how we can get through it and come out into a healthy, steady era of sound business instead of another silly and debilitating spree.

Futility of Passive Resistance

Why is it so frightening for businessmen, employees, all serious and patriotic citizens not to know—and not to be teaching and discussing sound economics and good sensible political conduct?

It's because of this new kind of robber barons that have gotten more and more successful elsewhere out around the world during the last 30 years. They always first get themselves outwardly cloaked in the mantle of the common man. But their objective is power—and power direct rather than through money. Their methods are therefore political and not commercial (which is where our ability is).

Businessmen, unthinkingly continue to devote themselves purely to the customary commercial pursuits, have meanwhile in country after country been gradually weakened and then displaced. Along with their displacement went freedom—for all the people—freedom and any hope of human dignity, plenty, and the good life.

After seeing this at work abroad among our enemies and our allies alike for thirty years, what do we find ourselves doing? We rich Americans, whose so-called "ill-fed, ill-housed, and ill-clothed lower third" are so well off that they are the envy of the rest of the world! We natively smart Americans, who not only have fine basic education but have had others' experience enacted right before us so we don't have to theorize or experiment or take any foolish chances!!

How are we acting? What are we doing?

First, we are putting on a great spectacle of how sorry we are for ourselves. Our plight seems indeed tragic. We only treated ourselves to one million new homes last year—4½ million refrigerators—almost 5 million motor vehicles, on top of about 38 million already on wheels at the beginning of the year. We right now—with the possibility of some overdue readjustment looking us in the face—still seem to be making progress toward going out and getting in each other's way with another 4 or 5 million cars this year.

Second, we had all these new things and all these savings left after handing over taxes to our federal government at a rate of over $40 billion a year. And get this picture! Half of this $40 billion of taxes is being spent to ward off the foreign Communist menace to our system and safety, while right at the same time here at home too many of us in and out of government and unions and business are joyously, if not hysterically, embracing one after another of the very ideas, influences, features, or ingredients of collectivism (or communism with a small "c") that can surely lead us off the deep end into the same type of police state we so fear—the very police state of poverty, slavery, and hopelessness we are fighting with our billions to prevent from happening elsewhere.

What do we have to do to be saved, then? It seems to me all we have to do is just to do exactly as we do when we encounter any other unsound or unfair salesman out trying to compete for our customer's favor. We take a good look at our product, make certain again that it's right in function and price for the current market, and then go out to sell the daylights right out of the something-for-nothing boys.

Responsibilities of Citizenship

A distinguished M.I.T. professor told me in New York last week that he was beginning to believe that the missing in-

gredient in employee relations and community relations was summed up in the one word "politics"—or political action by manager, stockholders, bondholders, insurance policy holders, savings bank depositors, pensioners, and others with an interest in keeping the value of money honest, the standard of living rising, and the freedom of choice, speech and movement really free.

I would agree if he meant by political activity the mastery of sound economics and the insistence by citizens on sound economic teaching and practices by their representatives in government, in unions, even in the clergy, as well as in business.

Those who have been in Washington recently will know already that, while there is a selling job to be done there, the primary selling job must be done at the grass roots. The Senators and Congressmen are like furniture buyers sent to the annual market with not much leeway for their own discretion or taste. They do—and are supposed to do—what the folks back home want done.

Who is to do something about all these things? Who is to keep on—in the critical days ahead—talking to his Congressmen and friends about proper legislation in the public interest? Who is to learn, and then teach economics? Who is to put his citizenship duties ahead of his commercial duties?

I can't speak for others, but I can tell you it is the individual conviction of member after member of the force of 15,00 in G–E management not to look to others or to try to delegate this job of good citizenship to subordinates or to associations—but to do this job ourselves. Each one of us to the degree we can attain the personal facility and command the interest of others in the things we are trying to do in the public interest.

Many of us have seen—are seeing and writing—our Congressmen and Senators. We have testified on pending legislation before House and Senate Committees. We are telling our neighbors back at the grass roots what we think. We are learning economics and teaching economics to our supervision, our 200 thousand employees, our 7 million neighbors in our plant cities. We are discussing in print every controversial public issue that involves job-connected economics or public policy effect on us, our employees, or our neighbors.

I have outlined for you what we are trying to do in this wide area of industrial relations. Many other concerns facing the same problems are following a similar course, or a different course toward the same objectives.

Staving off the Tide

You gentlemen might well encourage and abet this trend toward the main essential—economics. Not only should students absorb all the economics they can but it would be wonderful if upon graduation they were equipped to be economic teachers. I mean by that not only to be equipped as teachers in the formal sense but as teachers who are able to debate the theories and practices of economics with tough and facile opposition over the radio, on television, at women's clubs, church meetings, and public meetings of all kinds. If we ever are going to be able to understand fully this wonderful system of ours, we have got to have a sort of "town meeting" going on constantly wherever citizens meet, from groups of two on up, and to lead such discussions we need sound students of economics.

You gentlemen could help too, in the various projects that are going on around the country now in the organization and conduct of adult economics courses. In this connection I would like to tell you something of what we in General Electric have done to encourage such adult economics courses. In Schenectady, last autumn, we assisted the Lions Club there in arranging a discussion course whereby members of a panel, led by a trained instructor, sat upon a stage in an auditorium and through discussion developed the theories of sound economics and applied them to their day-to-day operation. Subscribers included businessmen, union leaders, the clergy, and professional people

who sat in the audience and listened to the discussion going on on stage. The course was entitled "What Every Man Should Know About Business." This was entirely an experimental proposition but it was so well received that we circulated reports of it across a wide segment of our friends and contemporaries around the country. Since that time similar courses have been held elsewhere. In my own home city of Syracuse, the Citizens' Foundation conducted the course and drew a sell-out crowd of 700 throughout the full 13 weeks that it ran. Attendance was entirely voluntary and was paid for, by the most part, by the individuals attending. These people were happy to give up one night a week to learning fundamentals of our economic system.

At Grand Rapids, Michigan, I understand the course has had similar success and plans are underway now to continue the course at Worcester, Mass., and Bridgeport, Connecticut, and half a dozen other cities around the country. Hardly a day goes by but what we in General Electric receive queries about the success of the course and how it was conducted. This is a third area where you gentlemen might well indeed assist business in improving industrial relations.

What I think we all ought to do to contribute to the understanding, the preservation, and the improvement of our free and wonderfully productive system of incentives and competition are as follows:

(1) Before anything else we have got to be born again (and you can help in that rebirth). We have got to shake a life-time's habit of mind about values.

(2) We have got, of course, to provide good jobs and good bosses (and in the latter sphere you again can help us). And we have got to have this known to our employees, to their neighbors, and to the whole public.

(3) Then we come to this larger job itself. That's the job of deserving and getting a favorable economic climate for our operations, and then deserving and getting favorable recognition for the overall economic and social consequences of the way we have embraced this opportunity.

But it's got to be done if business management—in fact our free system—is to survive. I think it can be done if we will recognize and do something about it.

But businessmen need your help. We need your help to make more of us —and those to follow us—understand this wonderful system of ours—help to learn how to preserve and improve it rather than let it be damaged, or even perish. We need your help in seeing that a majority of citizens understand the economic facts of life, the proper working of our system, and the fallacy of all these contrary something-for-nothing fairy tales. With your help—and with similar help from educators everywhere—I feel sure that the bridge of industrial relations, the lifeline of our great free competitive enterprise system, will be a lasting and monumental edifice which will not and cannot be torn down!

An Employment Survey of Industrial Engineering Graduates of the Pennsylvania State College*

By GEORGE L. THUERING

Assistant Professor, Department of Industrial Engineering, The Pennsylvania State College

The first curriculum in Industrial Engineering in this country was started at The Pennsylvania State College in 1908, some 43 years ago. Upon the occasion of its fortieth anniversary in 1948 the Department felt that it would be appropriate if it undertook a study of its graduates to determine what they were doing and how they had fared since graduation.

The Department graduated its first two students in 1910. From 1910 through 1948, the period covered by this survey, 1051 students were graduated. In the two years since 1948 another 315 have received degrees in industrial engineering. As one might expect, during the early years the graduating classes were small and averaged about 10 men per year. Following World War I and coinciding with the "Efficiency Expert" era of industrial engineering, enrollment climbed and an average of 35 men per year received degrees. From 1925 through 1938 enrollment was fairly stable. Graduating classes averaged 21 per year with a high of 29 in 1927 and a low of 15 in 1933. The period of stability ended with the class of 1939, and a period of growth began. This growth, which actually started with the freshman class of 1935, was interrupted in 1944, 1945 and 1946 by the war, and was greatly accelerated by returning veterans in recent years. This year (1951) approximately 90 degrees will be granted, a drop from the maximum of 164 degrees granted in 1949.

*Presented at the 59th Annual Meeting of The American Society for Engineering Education, at Michigan State College, East Lansing, Michigan, June 25–29, 1951.

Method

The survey of the alumni was conducted by mail. It was possible to contact 880 of the 1051 graduates of the years 1910 through 1948, and replies were received from 615. This represented 51.8 per cent of all graduates or approximately 70 per cent of those contacted.

The replies were grouped and reported by five-year intervals starting with 1911. The one exception was the most recent group which contained the three years of

TABLE 1

COMPARISON OF NUMBER OF GRADUATES AND NUMBER OF REPLIES TO QUESTIONNAIRE

Years	Graduates	Replies	Per Cent Replies
1946–48	209	149	71.3%
1941–45	192	120	62.5%
1936–40	167	108	64.6%
1931–35	100	58	58.0%
1926–30	114	69	60.5%
1921–25	173	72	41.6%
1916–20	61	29	47.5%
1911–15	33	6	18.2%
1910	2	0	—
Totals	1051	615	58.1%

1946, 1947 and 1948. This grouping was decided upon as it was felt that a graduate's age, or the era in which he graduated, might have some influence on his work. It was also felt that the smaller number of replies from older graduates would be lost among the large number of replies from more recent and also considerably larger graduating classes. In a further attempt to facilitate comparison and reduce misunderstanding all results were reported in percentages of replies.

Results of Survey

A summary of the number of graduates and number of replies is given in Table 1. As one would expect, a greater percentage of replies was received from the more recent graduates. The highest percentage, 71.3 per cent, came from the 1946 through 1948 group and the lowest, 18.2 per cent, from the 1911 through 1915 group.

When the replies were analyzed, it was found that graduates were in a wide range of industries and in a variety of occupations in these industries. Table 2 shows the percentage distribution of graduates according to industrial fields.

Seventy-two per cent of all graduates were employed in the major industrial field of manufacturing. The 1941 through 1945 group with 78.3 per cent had the

TABLE 2

PERCENTAGE DISTRIBUTION OF GRADUATES BY INDUSTRIAL FIELDS IN WHICH EMPLOYED AND YEAR GRADUATED *

	Total	1946–48	1941–45	1936–40	1931–35	1926–30	1921–25	1916–20	1911–15
Agriculture and Forestry	.3	—	.8	—	—	—	—	—	—
Mining	.3	—	.8	—	—	1.4	1.4	—	—
Construction	.7	.7	.8	—	1.7	1.4	—	—	—
Manufacturing	72.0	75.2	78.3	77.8	76.0	69.5	54.2	55.2	33.3
Food and Kindred Products	2.6	2.0	2.5	2.8	3.5	4.3	—	6.9	—
Textile Mill Products†	3.3	3.4	1.7	8.3	3.5	1.4	1.4	—	—
Lumber, Furniture and Lumber Products	1.3	1.3	—	1.9	—	1.4	4.2	—	—
Paper and Allied Products	2.0	2.7	1.7	2.8	1.7	1.4	1.4	—	—
Printing and Publishing	.8	.7	—	—	1.7	2.9	1.4	—	—
Chemicals and Allied Products including Rayon	3.9	4.0	2.5	5.6	8.6	5.8	—	—	—
Petroleum and Coal Products	5.6	5.3	3.3	4.7	6.9	10.1	7.0	6.9	—
Iron and Steel and Their Products	12.5	14.7	14.2	15.8	3.5	7.2	11.2	13.7	16.7
Machinery	28.8	33.6	42.5	22.2	34.5	17.4	19.4	13.8	16.7
Transportation Equipment	3.3	2.6	3.3	6.6	5.2	2.9	—	—	—
Other Manufacturing Industries‡	7.7	4.7	6.7	7.4	6.9	14.5	8.3	13.8	—
Transportation	.8	—	.8	—	1.7	2.8	—	—	—
Communication	1.5	3.4	—	—	—	2.9	2.8	—	—
Utilities	1.6	1.3	2.5	.9	—	1.4	4.2	—	—
Other Industry Fields (Service)	17.9	12.8	9.2	19.5	19.0	14.5	29.2	41.4	66.7
Any Field Not Specified	2.5	2.0	.8	—	1.7	5.8	6.9	3.4	—
Unemployed	.8	1.3	1.7	—	—	—	1.4	—	—
Student	1.3	2.0	3.3	.9	—	—	—	—	—
Wife	.5	.7	.8	.9	—	—	—	—	—

* Adapted with some deletions and additions from the list in "The Engineering Profession in Transition," A Report of The Engineers Joint Council on the 1946 Survey of the Engineering Profession, prepared by Andrew Fraser. Page 71, Engineers Joint Council, New York.

† Including clothing but excluding rayon.

‡ A large part of this consists of companies manufacturing insulating, roofing and floor covering materials.

TABLE 3

PERCENTAGE DISTRIBUTION OF GRADUATES BY OCCUPATION (FUNCTION) AND YEAR GRADUATED

	Total	1946–48	1941–45	1936–40	1931–35	1926–30	1921–25	1916–20	1911–15
Sales*	15.4	17.5	16.7	13.9	10.3	10.1	19.5	17.2	16.7
Consultant	2.0	—	—	4.6	5.2	1.5	1.4	6.9	—
Own Business, Partner or Officer†	11.3	2.7	5.8	6.5	15.5	26.1	20.8	27.6	16.7
Technical Engineering	7.9	4.0	10.0	8.3	13.8	4.4	11.1	3.5	16.7
Manufacturing (Line)	9.2	4.7	10.8	9.3	12.1	16.0	8.3	6.9	—
Manufacturing (Staff)	42.2	50.4	47.5	57.5	39.7	36.2	25.0	13.8	—
Methods and Planning	6.9	10.7	8.3	11.1	5.2	1.5	—	—	—
Time and Motion	6.1	11.4	9.2	7.4	—	—	1.4	—	—
Costs	2.5	2.7	1.7	5.6	1.7	1.5	1.4	—	—
Coordination	3.3	2.7	5.0	3.7	3.5	1.5	1.4	6.9	—
Personnel	3.6	2.0	1.7	5.6	10.3	7.3	1.4	—	—
General Industrial Engineering	11.4	12.8	15.0	12.0	12.1	11.6	4.2	6.9	—
Other	8.5	8.1	6.7	7.4	6.9	13.0	15.3	—	—
Other	12.1	20.8	9.2	5.6	3.5	5.8	13.9	24.1	50.0

*Sales and sales engineering, does not include self-employed sales representatives.
†All self-employed, including self-employed sales representatives.

highest percentage in this field. Of the specific industries within the field of manufacturing, the machinery industry with 28.8 per cent and the iron and steel industry with 12.5 per cent employed the greatest number of graduates. These percentages are similar to but slightly higher than those obtained for Mechanical-Industrial Engineers in a nation-wide survey conducted in 1946. In the 1946 survey 65.6 per cent were in manufacturing, 11.2 per cent in iron and steel, and 22.4 per cent in machinery manufacturing.[1]

Of the remaining 28 per cent of the graduates who were not in manufacturing more than half were in service type activities. Service type work which included wholesale and retail trade, education, government service and similar activities employed 17.8 per cent of all graduates.

The only significant trend by years was a decrease in the percentage of older graduates in manufacturing and a corresponding increase in the proportion in service type work.

As a further aid to analysis Table 3 was prepared. This tabulation shows the distribution of graduates by occupation (function). Manufacturing (staff) positions were held by 42.2 per cent of all graduates with the second largest percentage, 15.4 per cent, in sales. The next three occupations in order of importance were own business, manufacturing (line), and technical engineering. Only 2 per cent were working as consultants or employed by consulting firms. As one would expect, the percentage of graduates who owned their own business or were partners or officers in corporations increased with an increase in age. Offsetting this was a decrease in the percentage of older graduates holding manufacturing (staff) positions.

A comparison of the data in Table 3 and similar data presented in a study of all engineers by The American Society for Engineering Education in the 1920's is interesting.[2] In the 1920 study it was

[1] "The Engineering Profession in Transition," A Report of The Engineers Joint Council of the 1946 Survey of the Engineering Profession, prepared by Andrew Fraser, page 87, Engineers Joint Council, New York.

[2] "Report of the Investigation of Engineering Education 1923–1929," Fig. 2, page 232, Volume I.

discovered that immediately after graduating 71.2 per cent of the engineering graduates were doing work that was primarily technical, and 28.8 per cent were doing work that was primarily administrative. However, among the graduates with more than fifteen years experience (fifteen to forty years experience) only 30.5 per cent were doing technical work, and 69.5 per cent were doing work that was primarily administrative.

If one considers as the 1920 study did the fields of sales, own business, manufacturing (line), and manufacturing (staff) in Table 3 to be primarily administrative work, and the field of technical engineering to be primarily technical, the following percentages result:

	Primarily Technical Work	Primarily Administrative Work
1916–20	3.5%	65.5%
1921–25	11.1%	73.6%
1926–30	4.4%	88.4%
1931–35	13.8%	77.6%
1936–40	8.3%	77.0%
1941–45	10.0%	81.1%
1946–48	4.4%	75.3%

This tabulation shows that the overwhelming majority of the graduates started in primarily administrative work and remained in that type of work. The percentage in primarily technical work was small and did not change with age or experience.

Summary

The findings of the survey can be summarized as follows:

1. Seventy-two per cent of all graduates were employed in manufacturing industries. More than half of this group was in iron, steel and machinery manufacturing.
2. The remaining 28 per cent of the graduates were employed in a great variety of industries and businesses with the majority in service type activities.
3. From the standpoint of occupational activity, 78.1 per cent were doing primarily administrative work. The largest single percentage, 42.3 per cent, had manufacturing (staff) positions with the next largest group, 15.4 per cent, in sales.

ANNUAL MEETING

June 23–27, 1952

Dartmouth College **Hanover, N.H.**

TIMELY TIPS

(Papers submitted for TIMELY TIPS *should not exceed 3 pages of typewritten, double-spaced material, including any mathematical formulas, and should contain not more than 2 illustrations.)*

The Questionability of Questionnaires

By ARTHUR M. HILL

Head, Mechanical Engineering Department, Tulane University

The questionnaire is a popular device for obtaining information on specific subjects. However, more thought might be given to the convenience of the person receiving it.

First, a self-addressed and stamped envelope should be enclosed.

Second, the mimeographed blank for answers should include the name and address of the originator of the questionnaire.

Third, date all questionnaires. It is just good engineering practice to date material and it might serve to jog the recipient into a reasonably prompt reply.

Fourth, before deciding on final form, try out the questionnaire on a fellow faculty member, preferably one who comes from a university outside of your community. Too often questions may seem clear to the writer, but will appear vague to others.

Fifth, remember that answering is time consuming; keep the questions to a minimum number.

Deflections by Euler's Double Integration Method

By G. SONNEMANN

Assistant Professor of Aeronautical Engineering, Drexel Institute of Technology

Professor M. W. Jackson clarified in his recent article* the relation between the Virtual Work, Dummy Load, Conjugate Beam, and Area Moment method for computing the deflections of a beam. The Euler Double Integration Method should also be clarified, or better, be simplified.

The inherent difficulty with the Euler Double Integration Method as presently taught in most schools is the great number of constants that have to be evaluated in any given problem. This basic difficulty can be readily overcome and one can reduce *any* elementary strength of material problem to one in which only *one* constant has to be evaluated. It can be readily seen that under those circumstances the Euler Double Integration Method becomes a more convenient method than the area moment method.

In brief one has the following consideration. Examination of Fig. 1 shows that the distributed load stops at point B.

* *Journal of Engineering Education*, October, 1951; Vol. 42, No. 2, pg. 112.

Due to this the equation changes for the bending moment once point B is passed. This causes the difficulty in evaluating the constants.

If one now makes use of the principle of superposition, namely, continue the downward load from B to the reaction C, then the bending moment equation remains the same. The only objection is the introduction of the additional downward load, and this objection is removed by introducing an equal and upward distributed load from B to C. Fig. 2 depicts this type of loading.

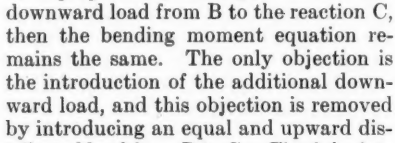

FIG. 1.

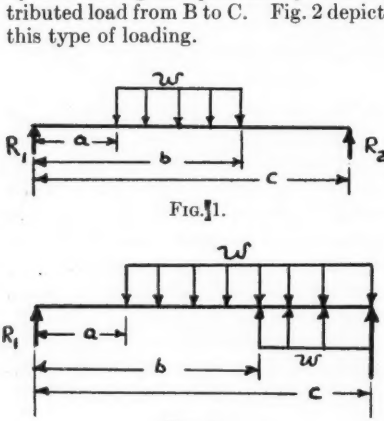

FIG. 2.

One sees that three equations are needed for each figure but let an inspection of the equations pertaining to Fig. 2 be made. The three equations are in the integrated form:

$$EIy = \frac{R_1x^3}{6} + c_1x + c_2 \quad [0 \leq x \leq a], \quad (1)$$

$$EIy = \frac{R_1x^3}{6} - \frac{w}{24}\{x - a\}^4 + c_3x + c_4 \quad [a \leq x \leq b], \quad (2)$$

$$EIy = \frac{R_1x^3}{6} - \frac{w}{24}\{x - a\}^4 + \frac{w}{24}\{x - b\}^4 + c_5x + c_6 \quad [b \leq x \leq c]. \quad (3)$$

Observe now that at the juncture points, i.e., $x = a$, $x = b$ Eq. (1) and (2) and Eq. (2) and (3), respectively, become identical except for the constants which are related by the relations:

$$c_1 - c_3 = 0 \quad (4); \qquad c_3 - c_4 = 0 \quad (5)$$

$$c_3 - c_7 = 0 \quad (6); \qquad c_6 - c_4 = 0 \quad (7)$$

or combining above

$$c_1 = c_5 \quad (8); \qquad c_2 = c_6. \quad (9)$$

Hence, Eq. (3) can be written in the form:

$$EIy = \frac{R_1x^3}{6} - \frac{w}{24}\{x - a\}^4 + \frac{w}{24}\{x - b\}^4 + c_1x + c_2. \quad (3a)$$

If one now agrees to omit the { } bracketed term when the quantity inside it is negative, it is apparent that Eq. (3a) reduces to Eq. (2) and Eq. (1) in the appropriate range of x. $c_2 = 0$ since at $x = 0$, $y = 0$. Hence, only *one* constant has to be evaluated to solve the problem.

Space considerations prevent a presentation of several types of problems but a short paper has been prepared by the author and will be furnished upon request. However, one can readily see that this method is a tremendous time-saving factor.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NOMINATION BLANK

"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

In order to make the election of officers of the Society as democratic as possible, members are urged to fill out the nomination form and return before April 15, 1952 to the Secretary, A. B. Bronwell, Northwestern University, Evanston, Illinois.

I nominate the following members of the Society for officers:

For President .....

.....

For Vice-President .....
(*In Charge of Instructional Division Activities—two years*)

.....

For Treasurer .....

.....

Signed .....

Title .....

Institution .....

Date .....

Minutes of the Executive Board Meeting

A meeting of the Executive Board of The American Society for Engineering Education was held on Friday, January 11, 1952, at Northwestern University, Evanston, Illinois. Those present were: S. C. Hollister, *President*, M. M. Boring, A. B. Bronwell, W. L. Everitt (substituting for J. H. Lampe), L. E. Grinter, C. L. Skelley, W. P. Kimball (guest), and B. Bowen.

Participation of Younger Faculty Members in ASEE Activities

The Secretary suggested that consideration be given to methods of stimulating active participation of the younger faculty members in the meetings of the Society. Most of the officers of the Divisions, Committees, and Sections of the Society are faculty members in the upper professorial ranks. Younger faculty members are seldom elected to office or called upon to present papers at Society meetings. On the other hand, the younger faculty members have the most to gain by participation in Society affairs, since this would help them to improve their teaching, give them a broader perspective on all facets of engineering education, and expand their acquaintances and associations in the educational field.

The Executive Board recommended that the Sections consider developing conferences and activities which would be arranged and managed entirely by younger faculty members of instructor and assistant professor rank. It was also suggested that adequate publicity be given to these conferences in order to stimulate widespread attendance and participation by the younger faculty members.

The Executive Board recommended that a paper contest be inaugurated, with entries limited to young engineering teachers. The subject of the paper contest would be announced by the ASEE and prizes would be awarded for the best papers. In order to stimulate Section activities among younger faculty members, each Section would establish its own rules for the paper contest and judge its own entries. The winning papers of the various Sections would then be submitted to a national judging committee which would select the first and second papers. These papers would be presented at the Annual Meeting of the Society and the awards would be made at this meeting. It was recommended that the contest be held during the school year of 1952–53 and that the first awards be presented at the Annual Meeting in June 1953.

A motion was passed, recommending the establishment of two prizes of $200 and $100 to be awarded for the best two papers submitted by young engineering teachers on a subject to be announced by the President. The contest is to be developed by the Sections of the Society, with the winning entries submitted for judging by a national committee appointed by the President.

This matter will be referred to the General Council for consideration at its meeting in June.

Program of Cooperation with Secondary Schools and Junior Colleges

One of the major projects of the Society during the coming year will be the development of closer working relationships between engineering colleges, secondary schools and junior colleges. President Hollister re-emphasized the need for counteracting the steadily falling scholastic level of secondary school education, especially in the sciences and mathematics, and also the decline in interest of high

school students in engineering as a career. Dean Everitt presented the views of the ECAC, stating that the problem is basically one of stimulating activity at the "grassroots" level and that the program of cooperation must necessarily be developed by the individual engineering colleges. However he stated that the ECAC's Committee on Secondary Schools could serve in a very useful liaison capacity by making information available to the engineering deans as to the methods and accomplishments of various colleges in this field.

Committee on Evaluation of Engineering Education

The program of "Evaluation of Engineering Education" has been voted by the Executive Board as one of the major projects of the Society during the coming year. A national committee under the chairmanship of Dr. Grinter will be appointed to study this problem. In addition, the deans of engineering colleges will be invited to appoint committees from among their own faculty members to cooperate with the central committee in this study. The recommendations of the institutional committees and those of the national committee will be consolidated and correlated into a unified report. President Hollister proposed that the national committee meet at Cornell University to discuss the broader issues involved in engineering education prior to the Annual Meeting.

Universal Military Training

President Hollister stated that the Engineering Manpower Commission is formulating a policy recommendation to be presented in testimony before Congressional committees which are holding hearings on the UMT Bill. He stated that there was considerable prevalence of opinion in Washington that the UMT Bill would not be passed by Congress. The stand taken by the Engineering Manpower Commission is that if Universal Military Training is adopted, every physically fit male of draft age should be required to serve in the highest capacity depending upon his abilities and education. There will then be no question of deferment, but rather each draft age individual will be assigned to work either in the Armed Forces or in industry in the capacity where his education and skills are utilized to the best interests of the mobilization program.

EJC Committee on International Relations

Deans Lassalle and Steinberg have been appointed to serve as the ASEE representatives on the EJC Committee on International Relations. The EJC Committee has been working with agencies of the government in planning technical missions to European countries. Another technical mission on engineering education and research is contemplated.

UNESCO

Dean Everitt explained that the approach of the ASEE in seeking membership in UNESCO should be made to the chairman of the Membership Committee. The list of persons serving on the Membership Committee has been sent to Dean Lassalle in order that he may prepare material for a direct approach to the UNESCO Membership Committee.

Resolution of the Engineering Drawing Division

The Executive Board discussed the resolution of the Engineering Drawing Division, requesting that the ECPD visitation committees include qualified teachers of engineering drawing. It was pointed out that engineering accreditation has always been on the basis of curricula and not on the basis of subdivisional areas of curricula. The ASEE in the past has not made recommendations to include teachers of particular subjects on the ECPD accreditation committees. It was the consensus of opinion that it would be an unsound policy for the ASEE to make such recommendations, since it would open the door to similar requests in other subject areas.

Fall Meetings of the ECAC and ECRC

The Executive Board discussed the possibility of holding the Fall meetings of the ECAC, ECRC, and General Council at the time of the Centennial of Engineering in Chicago. This would serve to strengthen the attendance at the Centennial program by adding the support of the ASEE. It would also make it possible for a somewhat different group of deans of engineering colleges to attend the Fall meeting of the ASEE than those who usually attend the meeting when it is associated with the Land Grant College Asociation meetings.

The Executive Board voted to hold the Fall meetings in Chicago during the first week of the Centennial of Engineering, as close to the Symposium on Engineering Education as possible, the details to be worked out by the Secretary.

Location of Annual Meetings in 1954 and 1955

Dean Everitt repeated his invitation to the ASEE to hold its 1954 Annual Meeting at the University of Illinois. It was the consensus of opinion that this location would fit well with the ASEE geographical rotation plan and also that the facilities at the University of Illinois should be entirely adequate for the Annual Meeting.

The Executive Board voted to hold the 1954 Annual Meeting of the Society at the University of Illinois, the details of the meeting to be worked out between the Secretary of the Society and Dean Everitt.

President Hollister presented an invitation from Cornell University to hold the 1955 Annual Meeting at Cornell. The last meeting of the Society held at Cornell University was in 1934. President Hollister will prepare a letter of invitation to the Society. No action was taken on this proposal.

Plans for 1952 Annual Meeting

Dean Kimball outlined some of the plans for the next Annual Meeting at Dartmouth College, June 23–27, 1952.

Dean Kimball stated that the anticipated expenses for the Annual Meeting would be on the order of $4,300. This would require a registration fee of $4.00 per member, with no additional charge for other members of the family. A previous ruling of the Executive Board and General Council authorized the host institution to charge a registration fee not to exceed $4.00 per member. The Executive Board approved the registration fee recommended by Dean Kimball.

Dean Kimball extended an invitation from President Dickey to members of the General Council and their wives to be the guests of President and Mrs. Dickey at a dinner on Monday evening. The Secretary suggested that the newely elected members of the General Council, representing Sections of the Society, be invited to attend the Monday evening dinner, even though their term of office does not begin until ten days after the Annual Meeting. This would enable the new Council members to become oriented to the problems of the Society before taking office. The Executive Board approved this recommendation.

Dean Kimball stated that all members present and guests will be invited to a reception at the home of President Dickey from 4:00 to 6:00 P.M. on Tuesday afternoon.

Report on the Secretary's Office

The Secretary presented a report on the operations of the headquarters office. This report stated that the ASEE has operated with a small headquarters staff on a "decentralized" plan, whereby the Divisions, Sections, and Committees of the Society assume much of the responsibilities for their respective areas of operation. The headquarters staff concentrates its principal attention upon the major projects of the Society, although it also has the responsibility for coordinating the activities of the various Councils, Divisions, and Sections of the Society; editing the Journal; maintaining the membership records; arranging for the Annual Meeting; and handling the Society's finances.

This basic plan of operation has made it possible to carry on the Society's business with a part-time secretary and two office secretaries and with an annual dues structure of from $5.50 to $7.00 per member.

With the growth in size and operations of the ASEE, it has become necessary to add to the secretarial staff in order to relieve the Secretary of some of the routine responsibilities and free a portion of his time for developing liaison work between the ASEE and other organizations and government agencies. The report recommended the following:

(a) The employment of an assistant secretary on the basis of one day a week, at a salary of $800 for the six months period from the present time until July 1. The assistant secretary would review manuscripts submitted for publication in the Journal and in general supervise the editorial work of the JOURNAL OF ENGINEERING EDUCATION. It was recommended that Professor C. E. Watson, chairman of the Department of Industrial Relations at Northwestern University, be appointed to this post.

(b) An appropriation of approximately $780 be made for the purchase of two dictaphone machines for the office. These would substantially increase the volume of correspondence which can be handled by the office secretaries.

(c) It was recommended that an additional $200 be appropriated for stenographic assistance.

The Executive Board voted to approve the foregoing recommendations.

The report also presented a projected estimate of the income and expense of the Society for the next three fiscal years and included a summary of costs for several different plans of expansion of the Secretary's office.

Applications for Associate Institutional Memberships

The Executive Board voted to approve the following applications for Associate Institutional Membership.

Caterpillar Tractor Company
General Electric Company
International Minerals & Chemicals Corp.
International Nickel Company
International Textbook Company
John Wiley and Sons, Incorporated
Macmillan Company
McGraw-Hill Book Company, Incorporated
Reinhold Publishing Corporation
Scott Paper Company
Standard Oil Company (Indiana)
West Penn Power Company
Westinghouse Electric Corporation

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

New Members

ANDERSON, ROY H., Assistant to Works Manager, Diehl Manufacturing Company, Somerville, N. J. A. A. Nims, F. A. Russell.

ATKINSON, RANDALL F., Assistant Professor of Architecture, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, P. E. Hemke.

BEERS, ROLAND F., Professor of Geophysics, and Head, Department of Fuel Resources, Rensselaer Polytechnic Institute, Troy, N. Y. P. E. Hemke, A. A. K. Booth.

BERGESEN, ALF O. R., Special Student, Mechanical Engineering, University of Rochester, Rochester, N. Y. J. H. Belknap, A. B. Bronwell. (Reinstatement)

BLATHERWICK, ALLAN A., Instructor in Mathematics and Mechanics, University of Minnesota, Mineapolis, Minn. F. E. Miller, G. J. Schroepfer.

BURTON, ROBERT E., Manager, Control Division, Engineering Dept., E. I. du Pont de Nemours & Company, Wilmington, Del. T. H. Chilton, B. M. Taylor.

BUTLER, HAROLD T., Instructor in Management, Economics, History, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, P. E. Hemke.

CAMPBELL, HENRY, Associate Professor of Civil Engineering, University of Rhode Island, Kingston, Rhode Island. T. S. Crawford, H. E. Graves.

CAMPBELL, ROBERT G., Assistant Professor of Aeronautical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. P. E. Hemke, A. A. K. Booth.

CLOUD, HAROLD A., Instructor in Agricultural Engineering, University of Minnesota, Minneapolis, Minn. A. Hustrulid, A. M. Flikke.

CRAINE, LLOYD B., Assistant Professor of Electrical Engineering, University of Idaho, Moscow, Idaho. P. Mann, J. H. Johnson.

CRAWLEY, STANLEY W., Assistant Professor of Architecture, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, P. E. Hemke.

CURTISS, ARTHUR N., Plant Manager, RCA Victor Division, Los Angeles 64, Calif. S. C. Hollister, A. B. Bronwell.

DRAKE, CAROLINE C., Assistant Librarian, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, E. A. Chapman.

EMMERSON, GEORGE S., Lecturer in Mechanical Engineering, University of California, Berkeley, Calif. R. A. Fayram, A. K. Oppenheim.

FALES, WILLIAM D., Dean Textile School, Rhode Island School of Design, Providence 3, R. I. G. N. Reed, R. B. Finch.

FIELD, CROSBY, President, Flakice Corporation, Brooklyn, N. Y. S. C. Hollister, A. B. Bronwell.

FOSTER, JOHN E., Professor and Head, Engineering Department, New Bedford Textile Institute, New Bedford, Mass. G. N. Reed, R. B. Finch.

GAUVIN, WILLIAM H., Associate Professor of Chemical Engineering, McGill University, Montreal, Canada. R. M. Boarts, E. E. Stansburg.

GILKESON, MURRAY M., Assistant Professor of Chemical Engineering, Tulane University, New Orleans, La. F. M. Taylor, L. H. Johnson.

GROSVENOR, A. W., Professor and Head, Department of Metallurgical Engineering, Drexel Institute of Technology, Philadelphia, Pa. A. H. Repscha, J. B. Baker.

GUY, WILLIAM T., Jr., Instructor in Applied Mathematics and Astronomy, University of Texas, Austin, Texas. R. Guernsey, Jr., R. P. Felgar, Jr.

HARRIS, HIRAM D., Professor of Electrical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, P. E. Hemke.

HAYWARD, BERTRAND W., Director, Philadelphia Textile Institute, Philadelphia, Pa. G. N. Reed, R. B. Finch.

HENDLER, ARTHUR S., Assistant Professor of Mathematics, Rensselaer Polytechnic Institute, Troy, N. Y. A. A. K. Booth, P. E. Hemke.

HOWARD, GEORGE W., Chief, Technical Service Dept., Engineer Research & Development Laboratories, Fort Belvoir, Va. L. H. Johnson, H. L. Bowman.

HUGHES, GROVER W., Instructor in Mechanical Engineering, University of Arkansas, Fayetteville, Ark. G. F. Branigan, R. G. Paddock.

JACKSON, ROBERT F., Associate Professor of Mathematics, University of Delaware, Newark, Del. A. P. Colburn, M. J. Bergen.

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339 new members this year

(*Continued from page 353*)

Those who missed the extremely interesting trip to the Columbia University Cyclotron in order to make the equally enjoyable inspection of Pavelle Color Laboratories, were not without an insight into the field of atomic behavior. Dean Dunning's brilliant talk at the annual dinner on the strides being made in the practical application of Atomic Energy was explosive in its revelations and his unique demonstrations were entertaining in the extreme. His talk created a profound interest in the unlimited possibilities of this relatively new science.

Your Executive Committee met on Wednesday evening to discuss the report of the Policy Committee, and to approve the program for the next annual meeting at Dartmouth. The Policy Committee, consisting of Professors Higbee, Hoelscher, and Justus Rising, submitted a specific policy for the selection of men to be given the Division's Distinguished Service Award, and this policy was approved by the Executive Committee. It will be published in a future issue of the *Journal of Engineering Drawing*. With respect to the trend toward reduction of time devoted to drawing in engineering curricula, the Policy Committtee reported that it has initiated definite action for corrective measures, and recommended a continuing policy. Pending further developments this report was accepted by the Executive Committee.

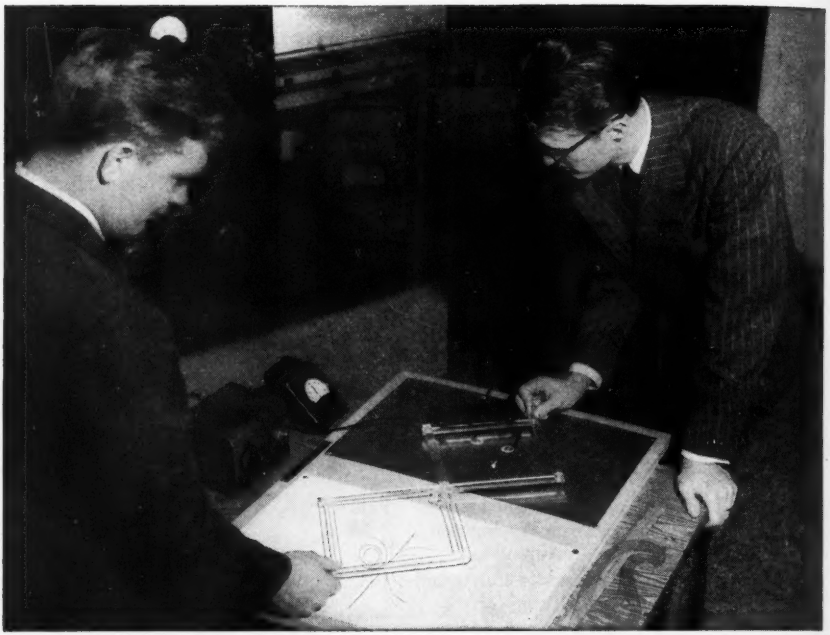
The topics selected for the June meeting cover a broad range of interests, and the list of speakers is headed by Dean S. C. Hollister, President of the Society. Better make plans now for that trip to Dartmouth. Everyone else will be there—why not you!

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Pennsylvania State College	April 18–19, 1952	E. B. Stavely, Pennsylvania State College
Illinois-Indiana	University of Illinois	May 17, 1952	D. G. Ryan, University of Illinois
Kansas-Nebraska	University of Nebraska	Nov. 16–17, 1951	Kenneth Rose, University of Kansas
Michigan	University of Detroit	May 10, 1952	W. P. Godfrey, University of Detroit
Middle Atlantic	Newark College of Engineering	December, 1951	S. J. Tracy, Jr., City College of New York
Missouri	University of Arkansas	April 5, 1952	R. Z. Williams, Missouri School of Mines
National Capital Area	Howard University George Washington University	February 5, 1952	W. Oncken, Jr., Bureau of Ordnance
New England	Worcester Polytechnic Institute	Oct. 18, 1952	E. T. Donovan, University of New Hampshire
North Midwest	Iowa State College	Oct. 3–4, 1952	S. J. Chamberlin, Iowa State College
*Ohio	Ohio State University		W. F. Brown, University of Toledo
Pacific Northwest	University of Washington	April 25–26, 1952	T. H. Campbell, University of Washington
Pacific Southwest	California State Polytechnic College	Dec. 29–30, 1952	S. F. Duncan, University of Southern California
Rocky Mountain	University of Wyoming	April 19, 1952	E. J. Lindahl, University of Wyoming
Southeastern	Clemson College	April 10, 11, 12, 1952	R. L. Sumwalt, University of South Carolina
Southwestern	University of Houston	April 11 & 12, 1952	H. P. Adams, Oklahoma A. & M. College
Upper New York	Alfred University	October 10–11, 1952	R. M. Campbell, Alfred University

Members of the Society are welcome at all Section Meetings

* No Date Set.



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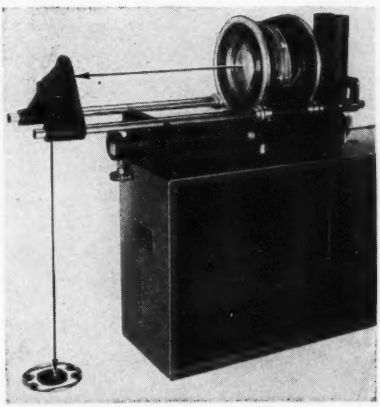

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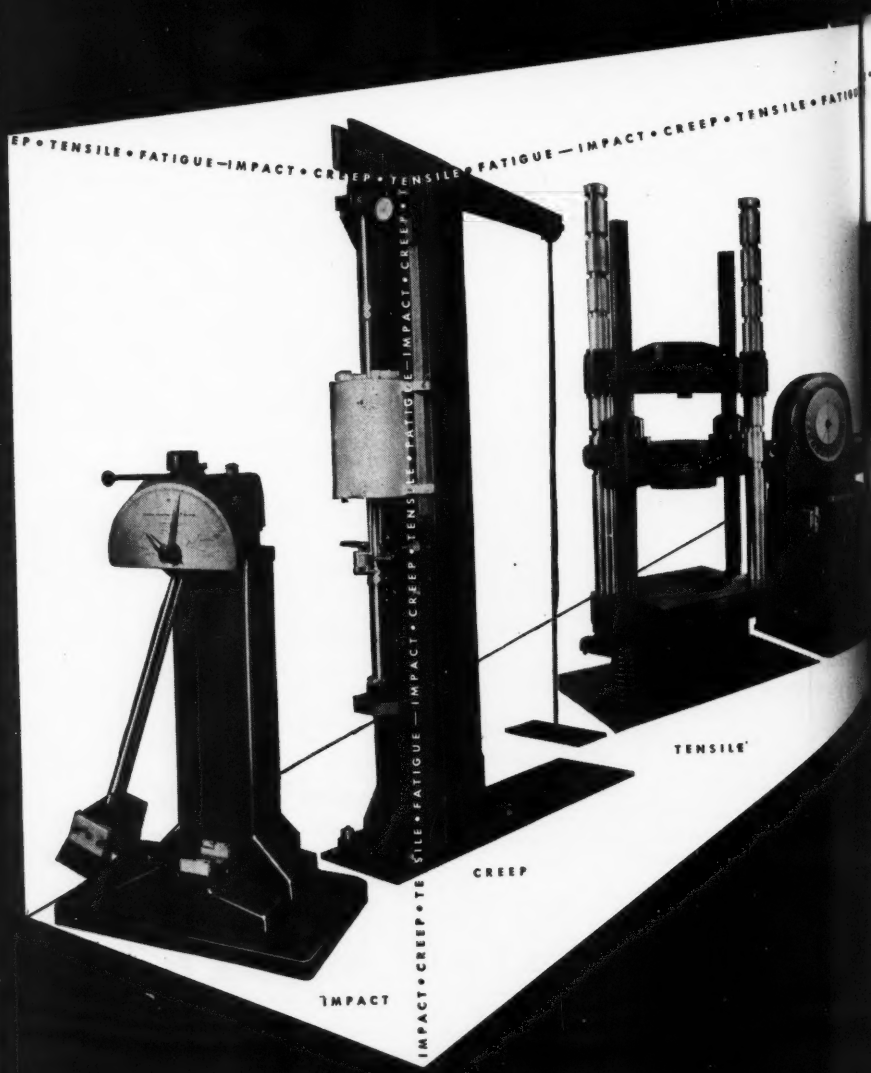

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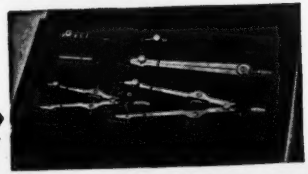

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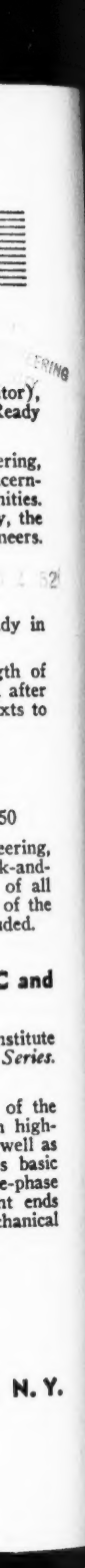
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